"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 573:001 Teaching Science in the Secondary School
Spring Semester, 2011

Instructor:	Stephen Burton
Date and Time:	Tuesday, 7:20 – 10:0 pm
Class Location:	Robinson A: 412
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Office Hours:	By appointment

Text 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

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

Online Resources

- Commonwealth of Virginia (2003). *Standards of Learning for Virginia Public Schools.* Richmond, Virginia. Retrieved on August 14, 2007 from http://www.pen.k12.va.us/VDOE/Superintendent/Sols/home.shtml. Print out grades 6- Physics.

- 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://courses.gmu.edu. Use the same login as your GMU email.

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;

- 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;
- 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;
- Construct cohesive science units that include science lessons and hands-on experiences that address the needs of a variety of student populations including English language learner, special needs students, and gifted and talented students;
- Learn about science laboratory safety and plan teaching activities that highlight safety;
- Work collaboratively with peers to teach and discuss science and science teaching.
- Incorporate environmental sustainability into teaching paradigms and into daily life.

Relationship to Program Goals and Professional Organizations

EDCI 573 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 573 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
- 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".
- Bring your own plate and reusable cup for snacks during break.

College Expectations and University honor Code

The Graduate School of Education (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://www.gmu.edu/catalog/apolicies/#TOC_H12 for the full honor code.
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.
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 15 of those hours during this class. The university will place you in the field if you are not already teaching. EVERYONE needs to register on the website even if you are teaching, so that GMU has a record of where/when everyone did this 15 hours of field work.

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

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 are graded. Each graded assignment will be assessed using a scoring rubric which will be handed out before the assignment is due. Approximately half the rubrics will be based on fulfilling the specified criteria for the project and half the rubric will be based on the quality of work. The rubrics are available on the Blackboard website at the beginning of the semester. 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).

Assignments	***Points***
Unit Plan	25
Microteaching	15
Planning Project	10
Safety Assignment	5
Underrepresented Scientist Report	5
Clinical Interview	15
Field Experience	20
Class Participation	5
	100

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

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.

Feel free to submit assignments either electronically or as a hard copy. Considering the length of the Unit Plan it may be a good idea to submit it on disk, as two copies are required.

Some assignments ask for two copies to be submitted. One copy will be placed in the class collection for use by future students. If you choose, you may delete or otherwise conceal your name on the second copy of submitted assignments.

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.

1. The Unit Plan

The unit plan is one of the gateways for the Secondary Education Program. **You will need to successfully complete this project in order to continue in the GMU degree program.** Your curriculum unit plan will reflect your ability to incorporate practical and theoretical aspects of teaching ranging from pedagogical methods to technology, inquiry, safety, the nature of science, and assessment. The assignment will also assist you in considering the various logistical and management problems that must be overcome in order for the greatest amount of learning to take place in finite amounts of time. This should be a product that you will teach someday!

These learning events/lessons must be connected and integrated, connecting each lesson to the next at the grade level of your choice. **The unit plan is at least 4 weeks (20 hours, ~10 lessons w/ block scheduling).** *You may share ideas, materials, and resources with your classmates, but you must write your own lessons for your unit.* Safety considerations, pedagogical approach, nature of science, soundness of activities, inclusion of technology(ies) and "connectivity" are all important considerations for an excellent Unit Plan. You should have the students engaged in hands-on science at least half of the time. Though you will outline a four-week unit plan, you will only fully develop two weeks (10 hours) of daily lesson plans with all

support materials. You are to find, adapt, and/or create the activities done by the students. Within your unit you will place explicit teaching based on the nature of science to enhance your students' knowledge of science as a way of knowing. Your unit should be developed in sufficient detail (including student and teacher support materials) that you or a substitute teacher could use it to teach from.

A Wiki is set up on the Blackboard site for you to submit lessons as you develop them for feedback. The instructor as well as your fellow students will have access to read and comment on your lessons. Teaching is a collaborative activity and seeing what others are doing to create their lesson plans will spark wonderful ideas, so keep checking the Wiki and provide your classmates feedback.

All unit plans will include:

a. Overview (3-4 pages using the following headings)

Description of Students

In a very brief overview, describe the audience for which the unit is designed.

Theme

This is the topic for the unit.

Unit Question

This is the guiding question that the students will be investigating about the theme/unit.

Daily Questions

Each daily lesson plan will include at least one question for the day. In this section, list out the daily questions in order to show the "connectivity" of the ideas.

Philosophy of Science Teaching

This is a minimum 250-word description of your rationale for planning the subject matter content and teaching strategies for this unit including supporting research and theory learned through this class.

Nature of Science Prompts

Use this section to describe the connection of the science content to the aspect(s) of the nature of science (from the 7 aspects) you chose for your unit. Include the reasons for your placement of the developmental stages in terms of the learning processes. Also include why you think your chosen content area fits well with those aspects of the nature of science.

Standards of Learning

List the main standards including their codes from the Virginia Standards of Learning documents.

National Science Education Standards

List the standards from the National Science Education Standards that this unit addresses. Include the code (i.e. Content Standard B.1) for each standard.

Assessment Plan Overview

Summarize the multiple forms of assessment that will be embedded in the unit. Describe how the students' learning will be assessed both formally (graded) and

informally (not graded). Identify the assessments as diagnostic, formative, or summative.

Sustainability

Explain the ways in which you can infuse the idea of reducing negative human impact on the environment in your curriculum. Also explain ways you can incorporate practices that conserve resources into your daily teacher routines.

b. Schedule

Include a one-page overview/list showing the science content being studied each day for four weeks. This could be displayed as a calendar from your Annual Planning assignment. Indicate the two weeks (10 hours) of lessons you have fully developed with all support materials.

c. Daily Lesson Plans (1 lesson plan for each day for four weeks - see attached format)

Create a series of lesson plans that will include **daily questions, materials, learning activities including how long each activity will take, and assessment**. The daily question should relate to the unit question, the teaching activities should directly address the daily question, and the assessment should interpret student understanding of the daily question. As part of each lesson plan, **include key discussion questions that you will ask the students while introducing, discussing, or summarizing concepts**.

d. Support Materials (all materials for two consecutive weeks of the daily lesson plans)

For at least two consecutive weeks of the daily lesson plans, you will develop all support materials that the teacher and students will use. For teaching and learning activities **include each sheet of paper distributed to the students to carry out the daily lesson plans - laboratory experiments, activities, worksheets, instructions, assessments, rubrics, etc.** Attach these to the appropriate lesson plan. **Overhead transparencies (paper copy), powerpoint slides (on paper) and other teaching aids** used during the unit should also be included. Select your two weeks in mind to illustrate the following three types of lessons: **introducing new content, hands-on assignments, and assessment of student learning**. Each day describe how the students' learning will be assessed both formally (graded) and/or informally (not graded). The assessment activities and how they will be assessed (i.e. rubrics) will be attached to the daily lesson plans**.** These activities should focus on the essential science concepts and connections, assess higher order thinking skills, and target different learning styles. Checking for understanding should be included daily. Include diagnostic, formative, and summative assessment. At least one of the days you choose to develop support materials needs to **include major assessment instruments and grading criteria for the unit**. The unit plan template included on this syllabus will help you account for all of the required components.

The rubric is based upon the requirements of National Council for Accreditation of Teacher Education (NCATE), the National Science Teachers Association (NSTA), and the Interstate New Teacher Assessment and Support Consortium (INTASC). With your completed unit, include a copy of the rubric on which you have scored yourself. **Please turn in two copies of your unit** – one for grading and a second for the class unit plan collection.

2. Micro-teaching

Research shows that the most effective teachers inform their practice by analyzing and reflecting on their teaching. We have the unique opportunity to teach to a special group of high school students in Fairfax County called the "teacher cadets" who are studying principles of teaching at different high schools around Fairfax. You will have the opportunity to teach to them for 30 minutes from your unit lesson plans. They will provide feedback on your teaching skills and knowledge, while we will provide information to them about the process of becoming a teacher. Different high schools will be participating, so we have lots of options in terms of scheduling.

During the first 2 minutes of the lesson you will give an **overview** (orally and visually presented) of your lesson plans including standards and which part you are about to teach. For 25 minutes engage your classmates in **hands-on science** as if they were students at the grade level you teach. For the last 3 minutes, tell the class what **effective science teaching strategies** (orally and visually presented) you just demonstrated. This lesson will be **videotaped** for you. After you teach the lesson, you will review the videotape, and write a **5 page paper** that **describes** the teaching and learning goals you had for the lesson (about 1 page), **analyze** the lesson in terms of effectiveness (about 3 pages), and **reflect** on improvements needed and successful events in the lesson (about 1 page). We will share highlights of the micro-teaching experiences on the last class.

3. The Planning Project

The **Planning Project** is a three-part project that includes an **annual plan, quarterly projects, and lesson plan for the first day of class**. This project supports the massive planning effort that you have in getting your year started. For a class you are or will be teaching, plot on monthly planning schedules/calendars the science units of study including weekly topics. Then develop integrated quarterly projects that your student will do. Lastly, create a daily lesson plan for the first day of science class that you will teach using the template provided on the syllabus.

The **annual plan** is an outline of your plans for the year. For each science unit of study, indicate the length of time you predict that each unit will take and break that unit/time span into weekly science topics. For example, a five-week unit on the five senses may have as weekly topics - sight, sound, taste, smell, and touch. **The annual plan outlines what you will teach, not how you will teach**. To get started, take monthly planning schedules/calendars and label each month, day, and school holiday. Then, indicate the science units and weekly topics you plan to cover on the monthly schedules. To assist you with this project consult school division, state, and national standards, content text books, and the Virginia Science Standards of Learning Curriculum Framework.

For the **four quarterly projects**, you will design a student project for each quarter that provides students with a unifying experience for the quarter. The projects should relate to the topics being studied during each quarter and should include a variety of learning strategies such as individual research papers or group presentations. For the projects, consider including science that is relevant to the social studies theme for the year, science that will enhance learning on a field trip, science fair projects (check out the *Students and Research* book for ideas), science

demonstrations, and/or major science events of the year such as an eclipse. One of the topics should incorporate a sustainability project. While choosing topics, think big ideas!

Conclude this project by planning the **first day** of science class for the year using the daily lesson plan template in this syllabus. You have only one chance to make a first impression. Consider from the student's perspective, what impression you will make?

4. Four-part 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 safety related assignment that engages students and teaches the importance of safety in the science classroom, and (4) 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."

5. Underrepresented Scientist Report

Research shows that students do not have a realistic understanding of the scientific community. The **underrepresented scientist report** is a one-page mini research assignment that addresses this need. Lists of prominent female scientists and minority scientists can be found easily online. You will investigate one scientist, either female or minority, in encyclopedia type resources. For your scientist, create a one-page report that includes a **drawing/picture/chart/diagram** that shows something significant about the scientist and a short descriptive **written summary** about the scientist. This information will be shared in class. Also, be prepared to talk with your classmates about your scientist and what his/her life story shows us about the nature of science.

6. Clinical Interview

You will find an adolescent to interview about a science concept. The purpose of this assignment is for you to gain experience in a one-on-one setting to see how learning occurs. You will be given more detailed instructions in class, but overall the task is to be completed in the following sequence:

1) Identify two concepts from your respective instructional disciplines for which you will write a sequence of evaluative questions.
2) For each concept, write two easy questions, two moderately difficult questions, and two more difficult questions. Consult Bloom's Taxonomy for ideas for different cognitive levels of questions. Note, the easy questions should get at the student's understanding of the concept from past experience that may or may not be the product of schooling.
3) Audio tape an adolescent answering the questions and you probing for more understanding of the cognition of the student.

4) Writing a 3-4 page paper of the description of what occurred, an analysis of the learning of the student, and a reflection on what you learned

7. Field Experience

The purpose of the field experience is to provide you with the opportunity to (1) connect the goals of EDCI 573, science education theories, concepts and research findings to classroom/school practice, (2) to study and practice in a variety of classroom/school communities, and (3) to promote critical, self-reflection about your current and future teaching practice.

Your field experience should focus on two or more of the following:

1. the teaching process and teacher practices
2. implementing specific lesson plans
3. preparing and testing instructional materials with diverse learners
4. students' learning styles
5. student-student and student-teacher interactions
6. planning, implementing, and evaluating specific assessment instruments with diverse learners
7. teaching and learning with technology
8. students' behavior in a specific teaching/learning context
9. specific classroom management strategies
10. teacher interaction with students with special needs
11. teacher interaction with non-traditional students

You are required to observe and log-in a total of 15 hours, spread over the semester. During your field experience, you are required to keep detailed field notes, a log sheet indicating dates, times, subject area, grade levels, teachers' or principals' signatures and collect any relevant data.

At the end of your field experience, you are required to analyze your field notes as well as any other relevant data you collected and prepare a Field Experience Report. Your Field Experience Report must be between 4-5 pages in length excluding cover page, references and appendices. Your report must describe and discuss:

- your guiding study question,
- background and context of the class,
- procedure/method for how you took notes,
- how you made sense of your notes to find the themes you are writing about,
- summary of findings, and
- implications for your practice.

When possible you could volunteer as a science fair judge at a local science fair (more relevant in the spring than fall) as part of your 15 hours of field observation (not to exceed 3 hours). Keep your field notes in a file at home, and please be ready to provide them to the instructor if they are requested.

8. Class Participation

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.

DAILY LESSON PLAN

Date: **Subject:**

Materials needed:

Room Arrangement:

Essential Question (the big idea that drives the student learning)

Student Objectives (By the end of this lesson, my students will be able to...)

Things to Prepare Before Class

Opening Activity / Introduction (includes students' active participation and links to prior knowledge)

Teaching The New Objective (outline of activities, good questions to pose, major points, etc. – INCLUDE APPROXIMATE TIMES FOR ALL ACTIVITIES)

Closing Activity (includes students' active participation, reviews lesson, and relates to objective)

Safety considerations for the teacher:

Safety considerations for the students:

ASSESSMENT
1. How will you know your students are learning?

2. **Self-assessment**: How will you measure what went well and what would you change?

SCHEDULE
(PLANS MAY CHANGE ACCORDING TO STUDENT NEEDS)

Date	Class topics	Readings (due on the listed week)	Work Due (due on the listed week)
January 25th	• Syllabus • Why teach science? • Classroom Management • Getting the most from your field experience		
February 1st	• Blackboard • The Nature of Science	• Paideia Seminar Guidelines (handout) • Why is Teaching the Nature of Science So Important? (online) • Thinking Like Scientists: Using the Nature of Science as a Metacognitive Tool (handout) • The principle elements of the nature of science: Dispelling the myths (online) • Herr pp. 493 - 496	1. Opening question for Paideia Seminar
February 8th	• How Students Learn Science • A Private Universe • AAAS Atlas and Benchmarks	1. Blackboard postings on How Students Learn Science 2. Herr pp. 496-498 3. Herr pp. 106-142	1. One page seminar follow-up that addresses all of the questions below • What should a science teacher know about the nature of science? • What should a science student know about the nature of science? • In what ways should the nature of science be taught in a

			secondary classroom?
February 15th	- Technology - Equity issues - Cooperative Learning	1. Blackboard Postings on Technology, Equity and Cooperative learning 2. Herr pp. 243-256	1. Underrepresented scientist report
Feb 22nd	Planning lessons	1. Skim *National Science Education Standards* book 2. Bloom's Taxonomy handout 3. Herr pp. 517-528	1. Questions for Clinical Interview 2. Print Virginia Standards of Learning Framework from your content area
March 1st	Teacher tookit I • Inquiry • Cookbook labs	1. Blackboard Postings 2. Herr pp 458-470	1. Annual Planning
March 8th	Teacher toolkit II • Backwards design • The "E's"	1. Blackboard Postings	1. Quarterly Projects
March 15th – No Class – Spring Break			
March 22nd	Teacher toolkit II • Backwards design • The "E's"	1. Blackboard Postings	2. Quarterly Projects
March 29th	Teacher toolkit III • Multiple intelligences • Differentiated instruction	1. Blackboard Postings	1. Optional - Check on Field Experience Log 2. Optional – draft unit plans for feedback
April 5th	Teacher toolkit IV • Independent Research • Role playing • Discrepant events • Graphic organizers	1. Herr pp. 79-101 2. Herr pp. 151 - 154 2. Herr pp. 168-178 3. Herr pp. 473-488	1. Entire Planning Project (Annual Planning, Quarterly Projects, and First Day Lesson Plan) 2. Clinical Interview Paper
April 12th	Safety in the Classroom	Herr pp. 529-547	1. Four Pronged Safety Assignment
April 19th	Assessment - How do you know students are	Herr pp. 525-528 (again)	

	learning?		
April 26th	Philosophy of teaching Unit lesson presentations		1. Optional – draft unit plans for feedback 2. 250-word philosophy of teaching for your unit plan
May 3rd	Unit lesson presentations and reflection		1. Unit Plans 2. Field Experience Report 3. Microteaching Paper
May 10th	Unit lesson presentations (if needed)		

"Education is not a preparation for life; education is life itself." - John Dewey

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.

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.