Advanced Methods of Teaching Science in Secondary School

George Mason University, Fairfax, Virginia
EDCI 673 (3 credits)
Spring 2010

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Office Hours: by appointment
Course: Tuesdays 4:30-7:10PM
A412 Robinson Hall

Course Description:
Prerequisite: EDCI 573. This is the second course in a two-part sequence of courses for preservice science teachers. The course is designed to build on the fundamentals of curriculum design and teaching from the first course and focus on using technology for students to investigate science and adapting instruction and assessment for the diverse needs of learners. In additional to using technology in the schools, preservice teachers will modify lessons and assessments to address the diverse needs of students, implement those lessons and assessments with their peers, and analyze the effectiveness of those lessons and assessments.

Online Syllabus and Sample Assignments: http://courses.gmu.edu/

Online Teacher Resources: http://cehd.gmu.edu/crest/
(Special Education, Technology, Education, Science, Science Education, Standards)

I. Goals:

The preservice teachers will:

- Build a repertoire of science teaching and assessment strategies using technology to help students become scientifically literate, think critically and creatively, and see relationships among science, technology, and society;
- Demonstrate the use of technology in teaching science;
- Develop inquiry-based lessons for students to use technology to conduct science experiments, to research science issues, to analyze science data, and to communicate findings; and,
- Critique, adapt, and construct standards-based lessons including assessment and hands-on experiences for the diverse needs of learners including gender equity, cultural diversity, English language learners, gifted/talented students, and students with learning, physical, social, and emotional challenges.

II. Resources and Reading Materials:

National Science Standards and Benchmarks

- American Association for the Advancement of Science (1993). *Benchmarks for science Literacy*. http://www.project2061.org/tools/benchol/bolframe.htm
- National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press. http://www.nap.edu/readingroom/books/nses/html/

Virginia Standards

- Commonwealth of Virginia (2003). *Science standards of learning for Virginia public schools*. http://www.pen.k12.va.us/VDOE/Superintendent/Sols/ScienceSOL02.html
- Commonwealth of Virginia (2003). *Science standards of learning curriculum framework.* http://www.pen.k12.va.us/VDOE/Instruction/Science/sciCF.html

Articles (available on BlackBoard except as noted)

- Gallard, A. J. (2003). *Creating a multicultural learning environment in science classrooms: Research matters*. National Association for Research in Science Teaching.
- Haycock, K. (2001, March). *Closing the achievement gap*. Educational Leadership, 58(6).
- Miner, Nieman, Swanson, & Woods (2001). *Teaching chemistry to students with disabilities*. http://membership.acs.org/C/CWD/TeachChem4.pdf (Single free copies can be obtained from the American Chemical Society, 800-227-5558).
- Wilkinson (2001). Approaching a Workplace for All. *Chemical and Engineering News.*
- Northwest Regional Educational Laboratory:
    - Jarrett (1999). *The inclusive classroom: Mathematics and science instruction for students with learning disabilities*
    - Jarrett (1999). *The inclusive classroom: Teaching mathematics and science to English-language learners.*
    - Stepanek (1999). *The inclusive classroom: Meeting the needs of gifted students: Differentiating mathematics and science instruction.*
- Other readings as assigned by the instructor

Other Resources

- Bybee, R.W., Powell, J.C., & Trowbridge, L.W. (2008). *Teaching secondary school science: Strategies for developing scientific literacy.* Upper Saddle River, NJ: Pearson.
- 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.
- Nitko, A. J. & Brookhart, S. M. (2007). *Educational assessment of students*. Upper Saddle River, NJ: Pearson.
- Tomlinson, C. A. (1999). *The differentiated classroom: Responding to the needs of all learners.* Alexandria, VA: Association for Supervision and Curriculum Development.
- University of Washington, AccessSTEM Project, http://www.washington.edu/doit/Stem/
- Wiggins, G. & McTighe J. (2005). *Understanding by design: Expanded 2nd edition.* Upper Saddle, NJ: Pearson.

III. Relationship to Program Goals and Professional Organizations:

EDCI 673 is the second 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 and from their first science methods course. The course focuses on using technology in science teaching and learning and meeting the diverse needs of learners as called for by the *Standards of Learning for Virginia Public Schools* and *National Science Education 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 673 introduces students to integrating technology in learning and teaching science and adapting inquiry-based lessons and assessments to the diverse needs of students.

IV. Nature of Course Delivery:
Seminars are interactive sessions with all participants actively participating in cooperative or collaborative group activities. Advanced preparation for each seminar through reading, writing, and reflecting contributes to the success of the session and shows respect for your classmates. The sessions are an opportunity to share your knowledge and learn from others.

The focuses of this course are meeting the special needs of learners and technology. During the technology part of the course, three sessions (see schedule) will be held at a high school. You will attend the sessions for the subject area in which you are seeking certification.

Earth science	Dick Gongaware	Madison High School
biology	Julie Grunwald	Robinson High School
chemistry	Donna West	Woodson High School
physics	Tony Rugari	Edison High School

On-campus class sessions will be held in A412 Robinson Hall. Class will start with cooperative 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 strategies will be used to explore the themes of the week. All students will work collaboratively to analyze and evaluate teaching strategies, assess student work, and prepare for teaching.

V. Grading:
Since this is a graduate level course, high quality work is expected on all assignments and in class. Attendance at all classes is a course expectation. All assignments are graded using scoring rubrics and must be turned in at the beginning of class on the day they are due unless other arrangements have been made. Late assignments will be reduced by one full letter grade unless prior arrangements have been made with the instructor.

50% Differentiation Project
- Differentiated Lesson Plans and Assessments (25%)
- Peer Teaching of Differentiated Lesson and Assessment (10%)
- Analysis of Assessment (10%)
- Updated Philosophy of Science Teaching (5%)

40% Technology
- Group Technology Project Analysis (10%)
- Design Your Own Technology Project (15%)
- Science Web-Based Inquiry Activity (15%)

5% Field Experience Report

5% Readings and Class Activities

Assignments will be graded using the rubrics distributed in class, and letter grades will be assigned based on the relative amount of exceeds/meets/does not meet levels achieved.

VI. College of Education and Human Development Statement of Expectations:
Students are expected to exhibit professional behavior and dispositions (http://gse.gmu.edu/facultystaffres/profdisp.htm), follow the guidelines of the University Honor Code (http://www.gmu.edu/catalog/apolicies/index.html#Anchor12), and abide by the university policy for Responsible Use of Computing (http://www.gmu.edu/facstaff/policy/newpolicy/1301gen.html). Students with disabilities who seek accommodations in a course must be registered with the GMU Disability Resource Center (DRC). See www.gmu.edu/student/drc or call 703-993-2474 to access the DRC.

VII. Assignments:
All written assignments are to be word-processed. Documents should be double-spaced with 1" margins and 12 pt Times Roman or equivalent font. On the first page include your name(s), project title, and date. Electronic submission is encouraged except for the Differentiation Project. If you are turning in hard copies, staple all pages in one assignment together.

A. Differentiation Project. For this project, you will differentiate lessons plans and assessments to address the diverse needs of students, implement a lesson and assessment from those differentiated plans with your classmates, analyze the results of the assessment, and reflect on the experience. Your final submission will be a 3-ring notebook with the following sections:

Differentiated Lessons and Assessments
Based on the class readings, discussions, and activities on diverse learners, identify a category of learner (ELL, G/T, LD, ED, PD, etc) and differentiate three 90 minute lessons and the corresponding assessments from the unit plan you developed in EDCI 573 or another topic of your choice. Your notebook should include (each in its own section):

- Three 90 minute lesson plans (see sample)
- A description of the differentiation strategies for each activity/assessment with supporting research cited
- All handouts for students, including assessments

Peer Teaching of Differentiated Lesson and Assessment
You will implement one differentiated activity and a corresponding assessment (total of ~30 minutes) with your peers in class. Email the instructor a list of requested teaching materials at least two weeks in advance. In your notebook, include an evaluation of your peer teaching experience in which you discuss (1) what worked, (2) what didn't work, and (3) how you would improve the activity and assessment the next time you implement it.

Analysis of Assessment
For this section of your notebook, you will analyze the results of the assessment you administered during your peer teaching. Your analysis should include (1) the class average, (2) an item analysis for each question in the assessment, (3) a synopsis of the general trend(s)

revealed by the assessment, and (4) a discussion of how you would adjust your teaching as a result of the assessment analysis.

Updated Philosophy of Science Teaching
Based on your experience planning and implementing differentiated lessons and assessments, update your Philosophy of Science Teaching from EDCI 573. This should be an approximately 1 to 2 page description of your rationale for planning the subject matter content and teaching strategies for your modified lessons and assessments, including supporting research and theory learned through this class.

B. Web-Based Inquiry Activity. You will design one inquiry-based lesson that uses web-based technology in your science discipline for your students. The lesson you develop is to take advantage of the dynamic nature of the web. The purpose of this assignment is to use web-based technology to help your students learn science, not to use the web as a textbook. The central focus is to be on learning science and not the technology.

Your science web-based lesson should:

1. follow good lesson design (see rubric for details)
2. utilize at least one web-based science animation/simulation or science data set,
3. be inquiry-based,
4. help students understand science concepts,
5. include at least one aspect of the nature of science, and
6. be posted on our class Blackboard site under the sample web-based assignments for your discipline.

The lesson you design should take approximately 90 minutes for students to complete. Samples are posted on the class Blackboard site. Please email your assignment to the instructor for posting on Blackboard. Additionally, you will give a brief overview of your project in class. This is a short (~5 minute) synopsis of the activity and associated website(s).

C. Group Technology Project. Your subject area group (Earth science, biology, chemistry, or physics) will work with an in-service teacher to learn about the technology that is being used in the schools in your subject area. This project will be slightly different for every group but will tend to focus on a common base of technology: probeware, simulations, data and graphical analysis, Internet resources, and image processing.

Submit, via email to your subject area advisor and to your course instructor, an individual 1 page analysis that includes (1) what you learned about technology use in the science classroom, (2) concerns you have about using technology in your classroom, and (3) how you plan to continue to learn about available classroom technologies.

D. Design Your Own Technology Project (DYOTP). Since everybody has a different technology background, this project is an opportunity to design a technology experience that will help you most to use technology in your classroom in order to help students learn science. You are to spend at least ten hours investigating some aspect of technology that is new to you. For

example, teachers who have just been hired can learn about, set up, and use a technology in their classrooms with their students. Another example, for teachers who have never really used spreadsheets, is to analyze and graph data from student laboratory experiments, create some materials to help the students use spreadsheets for data analysis, and then try them with students.

The idea for this assignment is to spend sufficient time to be able to do something using technology that you could not do before. Random searching on the Internet is not the expectation. You need to get approval of your proposed project before you start. Your one page proposal (submitted to the instructor via email) will consist of:

1. Overview - a brief explanation of what you intend to do and learn that is new to you,
2. Rationale - how this will help students use technology to learn science,
3. Equipment and/or Software - where you will get the equipment and/or software, and
4. Documentation - how you will document your work in at least three ways.

Some examples of ways that you could document your work include a log that includes dates and times, samples of spreadsheets with corresponding graphs, lesson plans, worksheets, and samples of student work. At least one of the ways you document your work should focus on using the technology to help students learn science. The evidence you use to document your work should indicate what this project enabled you to do that were new to you and the potentially effective use of technology with students.

Your final report will include:

1. your approved proposal,
2. items to document your work, and
3. a 1 page analysis of what you accomplished in which you summarize what you did and discuss (a) what worked, (b) what didn't work, and (c) how to improve the next time you use the technology.

E. Field Experience. The purpose of the field experience is to provide you with the opportunity to (1) connect the goals of EDCI 673, 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. preparing and using instructional materials with diverse learners
2. planning, implementing, and evaluating specific assessment instruments with diverse learners
3. teaching and learning with technology
4. teacher interaction with students with special needs
5. 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 of relevant data collected and a log sheet indicating dates, times, subject area, grade levels, and teachers' or principals' signatures.

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 should be approximately 4 double-spaced pages excluding references and appendices. In your report, describe and discuss your guiding study question(s), background and context, procedure/method of study, data collection and analysis technique(s), summary of findings and implications for your practice. When possible, you should volunteer as a science fair judge at a local science fair part of your 15 hours of field observation (not to exceed 3 hours). You will turn in your field notes with your report.

VIII. Course Schedule:

Date	Topics	Projects Due	Readings
Jan 19	**Introduction & Syllabus** **Effective Science Teaching** •Nature of Science •Hands-on •Inquiry-based **Technology** •Blackboard		
Jan 26	**Differentiation** •Learning Disabilities (LD) •Physical Disabilities (PD) **Assessment** •Types of Assessment		Haycock NWREL – LD Wilkinson Miner, et al. Handouts
Feb 2	**Differentiation** •Social-Emotional Disabilities (ED) •Gifted and Talented (G/T)		NWREL – Gifted
Feb 9	**Assessment** •Constructing/Modifying Assessments •Implementing Assessments		Handouts
Feb 16	**Differentiation** •English Language Learners (ELLs) •Guest Speaker: Dr. Becky Fox		Gallard NWREL – ELL
Feb 23	**Assessment** •Analyzing and Evaluating Assessments **Technology** •Why use technology in teaching? •When is technology use appropriate? •How do you know when technology is		Handouts

Date	Topics	Projects Due	Readings
	being used effectively? •Web-Based Inquiry Activity		
Mar 2	**Technology** •Web-Based Inquiry Activity Presentation •Design Your Own Technology Project •Intro to schools – meet teachers	email Web-Based Activity to instructor by noon	
Mar 9	NO CLASS – GMU SPRING BREAK		
Mar 16	**Technology** – School Visit 1	email DYOTP Proposal to instructor by noon	
Mar 23	**Technology** – School Visit 2	email list of materials for presentation to instructor at least 2 weeks in advance	
Mar 30	**Technology** – School Visit 3		
Apr 6	**Assistive Technology Lab** (Thomp 221) •Emily McKeough	Group Technology analysis	
Apr 13	**Differentiation Project Peer Teaching**		
Apr 20	**Differentiation Project Peer Teaching**		
Apr 27	**Differentiation, Technology, and Assessment** •Universal Design	Field Experience Report	Handouts
May 4	**Technology** •Design Your Own Technology Project	Differentiation notebook DYOTP documentation	

INCLEMENT WEATHER: It is the student's responsibility to contact GMU (www.gmu.edu or 703-993-1000) to determine if class has been cancelled. I will adjust the syllabus, including rescheduling class sessions, as necessary. Every attempt will be made to limit the number of additional classes, and Tuesday, May 12 will be used as the preferred make-up day.