Advanced Methods of Teaching Science in Secondary School

EDCI 673
Spring 2004

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Office Hours
Tuesday 3:30-4:20PM
Tuesday 7:20-8:00PM
Or by appointment

3 graduate credits
Tuesday 4:30-7:10PM in A412 Robinson Hall, except as noted when we meet in the schools

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 for the diverse needs of learners. The preservice teachers will use technology in the schools, observe students with special needs, and conduct research on student learning.

Online Syllabus and Sample Assignments (password protected): http://blackboard.gmu.edu/

Online Teacher Resources: http://gse.gmu.edu/centersoffices/crest/index.html
(Special Education, Technology, Education, Science, Science Education, Standards)

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;
• 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, high and low achievement, and the physically, socially, and emotionally challenged;
• Conduct research on student learning, and
• Work collaboratively with peers to conduct classroom research on student learning.
Online Resources and Reading Materials:

National Science Standards

Virginia Standards

Articles
- American Chemical Society (800 227-5558) Free single copies

Special Needs Website Resources
- Northwest Regional Educational Laboratory, It’s Just Good Teaching
- Cultural Inquiry Process ([http://classweb.gmu.edu/cip/r/r-ind.htm](http://classweb.gmu.edu/cip/r/r-ind.htm))
- Inclusion in Science Education for Students with Disabilities. [http://www.as.wvu.edu/~scidis/](http://www.as.wvu.edu/~scidis/)

National Science Teachers Association
- National Science Teachers Association ([http://www.nsta.org](http://www.nsta.org)) Please join NSTA or your subject area national society.
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 the use of technology in learning and teaching science and adapting inquiry-based lessons to the special needs of students.

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 focus of the course is technology for half the course and meeting special needs of learners for the other half. During the special needs part of the course, five 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. All final technology presentations will be held at the same school.

earth science   Jim Jarvis   Jefferson High School
biology        Jay Calfee   Edison High School
chemistry      Donna West  Woodson High School
physics        Steve Scholla Oakton High School

On-campus class sessions will be held in A412 Robinson Hall (science lab). On weeks when assignments are due, class will start with approximately 30 minutes of 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.

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 using scoring rubrics. Approximately half the rubrics will be based on fulfilling the specified criteria for the project and half the rubrics 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) unless there are extenuating circumstances.

50%  Special Needs Project/Collaborative Action Research
     Collaborative Action Research Presentation (25%)  
     Collaborative Action Research Notebook (25%)  

50%  Technology Project
     Technology Presentation (10%)
     Design Your Own Technology Project (30%)
     Science Web-based Inquiry Activity (10%)

Honor Code:

“To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of George Mason University and with the desire for greater academics and personal achievement, we, the members of George Mason University, have set forth the following code of honor. Any individual who is caught in the act of cheating, attempting to cheat, plagiarizing, or stealing will be brought forth before a council of their peers. In the event that the individual is found guilty, he or she will be punished accordingly.” For further information, please refer to the University Catalog or Website at www.gmu.edu.

Assignments:

All written assignments are to be word-processed. On the cover page include your name(s), course title, project title, date, and where appropriate describe the science subject. Staple all pages in one assignment together. Make each project something that you will actually use within the next year. Please turn in two copies of the assignments that are turned in on paper so that one can become part of the archives of student samples.

Special Needs Project/Collaborative Action Research

For this project, you will conduct research on adapting instruction to meet the special needs of students in order to extend or improve their understanding of science. This is a multi-part project that will build across the first part of the semester. You will be part of a 2-3 member research team that will conduct research on special needs students, adapt a two week unit of study for students with special needs, implement your plans, and assess the students’ understanding of the science taught. The confidentiality of all students and all school personnel will be maintained at all times. No last names will be used. The research findings from your study will be presented in class and all artifacts will be compiled in one notebook that includes a table of contents and tabbed sections. See the schedule for due dates for drafts of your work in progress.

- Gathering Information About Special Needs and Your Students
- Planning for Teaching and Assessing Student Understanding
- Implementing Plans and Data Collection
- Data Analysis
- Collaborative Action Research Presentation and Findings Notebook
Research Teams and Students. Research teams (2-3 members) will be established by subject area specialty. Each teacher will conduct research on the learning of two students from different special needs categories - English Language Learners, gifted and talented, learning disabled, socially or emotionally challenged, and physically handicapped. For teams that fully collaborate, plan, and conduct research together, the total number of students can be reduced by one for each additional teacher on the team (i.e. two teacher team = three students, three teacher team = four students). You will be observing the interaction between the teaching and the students. These students do not have to be from the same class. However, it will be easier for the team and data analysis if they are and that the class meets at a time of day when it would be easiest for non-teaching team members to meet at the school. In addition if it would be helpful, you may create a “composite” student for a category. For example if you have two students who are both from the same culture and have similar English skills, you may consider both of them as one “composite” student. The teams in consultation with the instructor will adapt the guidelines of this project to work in their school settings.

Gathering Information. You will start your research by gathering information on students to meet their special needs. There are three parts to gathering information. They are:

- Observation – class and students
- Interviews – experts and students
- Readings – texts and other library/online information

The research will start by gathering information. You will observe students in a classroom situation. The team will create interview questions for the students and available experts. Only one team member will interview any particular student and the interview will be a casual conversation that takes no longer than five minutes. Talk to school specialists and experts in the field as they are willing. Further your research by reading text materials and online information.

Planning for Teaching and to Assess Student Understanding. Research indicates that curriculum alignment of the intended, implemented, and attained curriculum leads to increases in student learning. You will outline the unit (~ 2 weeks) being taught for this project and your plan for adaptations in instruction and assessment for special needs students. If your team is from different schools, it will greatly facilitate your teamwork, if your team is all teaching the same topic at the same time. The unit overview (~ 2 pages) will consist of:

- Description of Students in Class
  In a very brief overview, describe the audience for which the unit of study is designed.
- Theme
  This is the topic for the unit of study during this research.
- Unit Question
  This is the question that the students will be investigating about the theme/unit.
- Sub-questions (~1-2/week)
  List 2-5 sub-questions for the unit.
- National Science Education Standards
  List 1-3 standards from the National Science Education Standards that will be addressed in the unit of study. Also include the code for each standard.
• Standards of Learning for VA Public Schools
  List approximately 3 standards from the Standards of Learning that this unit addresses. Also include the code for each standard.

• Assessment Plan Overview
  Summarize the multiple forms of assessment that will be embedded in the unit. There should be clear connections among the unit question, sub-questions, and what is assessed. Describe how the students’ learning will be assessed both formally (graded) and informally (not graded).

• Adapted Activities
  Include a brief description of where the adapted activities that you have developed fit into the unit. Adaptations for the unit will be described in the individual student case studies.

You will conduct collaborative action research to investigate student conceptual understanding of the science for the unit you are teaching and adapting to special needs students. You will develop instruments to assess student understanding. You will collect samples of student work that you will analyze. For example, you could collect worksheets, laboratory reports, tests, and pre- and post writing samples. In addition, you will create diagnostic, formative, and summative assessment instruments to assess the students understanding of the intended curriculum. These instruments will be planned for all students and further adapted as needed for the special needs students.

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<th>Diagnostic</th>
<th>Formative</th>
<th>Summative</th>
<th>Confirmatory</th>
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<td>3 formats for assessment &amp; multiple question levels</td>
<td>3 formats for each assessment &amp; multiple question levels</td>
<td>3 formats for assessment &amp; multiple question levels</td>
<td>3 formats for assessment &amp; multiple question levels</td>
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The diagnostic, formative, and summative assessment cycle can be embedded into any unit of study whether it is a day, week, month, or yearlong. Diagnostic assessment is done at the beginning before the unit starts and is generally not graded. Formative assessment is short assessments done throughout the teaching of the unit, preferably daily. Formative assessments can be formal or informal, and graded or upgraded. Summative assessment is done at the end of the unit and is generally graded. Confirmatory assessment is done at a later time to see how enduring the learning is. Time is not sufficient to conduct confirmatory assessment as part of this research project. Three formats of questions or tasks on each assessment instrument are ideal for research triangulation. However, common sense needs to align subject matter, pedagogy, time, and resources. Effective questions include higher-level thinking.

Assessment instruments will be created and reviewed collaboratively with your group and contain multiple formats designed to demonstrate learning (i.e. drawing, performance, short
essay, multiple choice). All assessment data collected needs to be analyzed beyond just grading for evidence of understanding or misunderstanding. You will do your analysis first on the whole class and then specifically for each of the special needs categories you are studying. You will also analyze the effectiveness of the assessment instruments that you created.

**Collaborative Action Research Findings and Presentation.** Data analysis will be done qualitatively and quantitatively, through observation and analysis of student work. It will not only be conducted for each instrument used for assessment, but also across all instruments. You are looking for trends/patterns for what works and what doesn’t. You will also analyze the effectiveness of each instrument in assessing student understanding. (If you know statistical analysis procedures that are appropriate for your data, you are encouraged to use them in your analysis. However, learning statistical analysis and graphical representation of data is not an expectation for this project.)

Your team will present your collaborative action research findings to the class using PowerPoint. Each team will be allotted 30 minutes for their presentation. The presentation will begin by focusing on the team research and planning, then proceed to individual case studies and findings, and end by focusing on team findings. As part of this presentation, you will tell us about your students, explain adaptations that you made for them in your teaching, how you assessed their understanding, how you analyzed the results, and what you learned. You will show samples of student work as appropriate to illustrate your points so that your classmates can see and learn more about special needs adaptations.

Your final report will be in one notebook and have a table of contents and tabbed sections. It will include:
1. printout of PowerPoint presentation
2. unit plan overview
3. case study reports (1 for each special needs student)
   • case study (1-2 pages)
     o description of school and class setting
     o description of the student
     o plans for lesson adaptations for special needs, cite research to support plans
     o results of your efforts at the end of the project
   • samples of student work to support your results for each case study
4. research summary of what you learned (what worked, what didn’t, improvements)
   • analysis of the effectiveness of each data collection instrument
   • synthesis of findings across all students

**Technology Project**

The technology project consists of three separate projects that are completed independently.

**Technology Group Presentation.** Your subject area group (earth science, biology, chemistry, or physics) will give a 30-minute group presentation to the entire (combined) class demonstrating technology that is being used in the schools in your subject area. (Times may be
adjusted depending on group sizes.) The theme of all of the presentations will be energy transformation. This project will be 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.

The presentation will be planned as a group with your subject area advisor from the schools. Everyone in the group must participate in the preparation, delivery, and demonstration of technology. Plan your presentation to the minute, make sure that all technology works completely, and do not miss any part of any other presentation. You will need to do whatever is necessary to have the equipment setup ahead of time and functioning for your presentation. Make the presentation informative for teachers in the other subject areas. The most effective presentations have the audience participate. Prepare at least one handout (quality not quantity) to distribute to each person in the class.

You will also be responsible to take down any equipment after all of the presentations are over. While you are putting away the equipment, discuss how the presentation went and how it could be improved. Submit your presentation analysis (maximum of one page per group) via email to your subject area advisor and to your course instructor.

Design Your Own Technology Project. 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 provisionally hired can set up and use the 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 student 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 Software - where you will get the equipment and software, and
4. Documentation - how you will document your work in at least three ways.
(Hints: Good proposal writers will always use headings for the required sections in their proposal. Include as appropriate the 3Ss in your proposal – students, standards, and safety.)

Some examples of ways that you could document your work are 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. one page summary and critique of what you accomplished.

You will summarize what you did and critique (a) what worked, (b) what didn’t work, and (c) how to improve the next time you use the technology. You may work with a partner on this project, but you will each need to spend ten hours. If you collaborate with a partner to set up and use technology with students that is new to both of you, you can submit one proposal and one report.

**Science Web-based Inquiry Activity.** You are to design one inquiry-based activity that uses web-based technology in your science discipline for your students. The activity you develop is to take advantage of the dynamic nature of the World Wide Web (animations and real science data sets). It is not to use the World Wide Web as a textbook. The activity is to use web-based technology to help your students learn science. The central focus is to be on learning science and not the technology.

Your science web-based activity is to:
1. include at least one web-based science animation/simulation or science data set,
2. be inquiry-based,
3. help students understand science concepts, and
4. be posted on our class Blackboard site under the sample web-based assignments for your discipline.

For the purpose of this assignment, the activity you design should take no more than 90 minutes (one block period or approximately two 45 minute classes) for students to complete.

Sample activities are posted on the class Blackboard site. Before developing your own activity, review sample activities in all disciplines. These samples follow different styles of instruction. Analyze the samples and determine which style fits your style and your students’ needs best. Then, develop an inquiry-based activity to help your students learn science.
## EDCI 673 Schedule
### Spring 2004

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<tr>
<th>Date</th>
<th>Topics</th>
<th>Projects Due*</th>
<th>Readings**</th>
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<tr>
<td>Jan 20</td>
<td>Introduction &amp; Syllabus&lt;br&gt;Effective Science Teaching&lt;br&gt;Hands-on&lt;br&gt;Inquiry-based&lt;br&gt;&lt;strong&gt;Learners with Special Needs&lt;/strong&gt;&lt;br&gt;Select 2 students&lt;br&gt;Planning&lt;br&gt;Create interview questions&lt;br&gt;&lt;strong&gt;Technology&lt;/strong&gt;&lt;br&gt;CREST Website&lt;br&gt;Blackboard - Sign on</td>
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<td>Jan 27</td>
<td><strong>Learners with Special Needs</strong>&lt;br&gt;(Gathering Information)&lt;br&gt;Discuss readings/interviews&lt;br&gt;Planning/Collaborating&lt;br&gt;Multicultural Dialogue and&lt;br&gt;English Language Learners&lt;br&gt;&lt;em&gt;Becky Fox&lt;/em&gt;</td>
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<td>CREST - preview</td>
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<td>NWREL – Eng. LL</td>
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<td>Feb  3</td>
<td><strong>Learners with Special Needs</strong>&lt;br&gt;(Plan Teaching/Assessment)&lt;br&gt;Role models divide up reading&lt;br&gt;Discuss readings/interviews&lt;br&gt;Planning/Collaborating&lt;br&gt;Learning Disabilities (LD)&lt;br&gt;3 Senses Learning&lt;br&gt;Multiple Intelligences&lt;br&gt;Brain Research&lt;br&gt;Cooperative Learning&lt;br&gt;Multiple Reading Levels&lt;br&gt;Structured Notes&lt;br&gt;New Frontiers Seminar&lt;br&gt;&lt;em&gt;Paulette Royt&lt;/em&gt; – biology</td>
<td>ACS – Miner, etc.&lt;br&gt;NWREL – Lrnng Dis.&lt;br&gt;Read – your students</td>
<td>ACS - Wilkinson</td>
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<td>Feb 10</td>
<td><strong>Learners with Special Needs</strong>&lt;br&gt;(Implementing/Analyzing)&lt;br&gt;Physical Disabilities - safety&lt;br&gt;Social-Emotional&lt;br&gt;Gifted and Talented (GT)&lt;br&gt;New Frontiers Seminar&lt;br&gt;&lt;em&gt;Julia Nord&lt;/em&gt; – Earth science</td>
<td>NWREL – Gifted&lt;br&gt;ACS - Working Chem&lt;br&gt;Read – Physical Dis.&lt;br&gt;Read – Social-Emot.&lt;br&gt;Read - your students</td>
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<td>Feb 17</td>
<td>Learners with Special Needs</td>
<td>(Data analysis)</td>
<td>Read - your students</td>
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<td>Gender Equity</td>
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<td>Plan Presentation + Notebook</td>
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<td>Assistive Technology Lab</td>
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<td>Kristine Neuber</td>
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<td>Feb 24</td>
<td>Learners with Special Needs</td>
<td>CAR Presentation or Notebook</td>
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<td>Learners with Special Needs</td>
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<td>Science Web-based Inquiry Activity</td>
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<td>Action Research</td>
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<td>Mar  9</td>
<td>Spring Break - no class</td>
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<td>Mar 16</td>
<td><strong>Technology</strong></td>
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<td>Spreadsheets</td>
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<td>Plan - Design Your Own Tech</td>
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<td>Intro to schools-meet teachers</td>
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<td>Mar 23</td>
<td><strong>Technology</strong> - School Visit 1</td>
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<td>Mar 30</td>
<td><strong>Technology</strong> - School Visit 2</td>
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<td>Apr   6</td>
<td><strong>Technology</strong> - School Visit 3</td>
<td>Proposal – Design Your Own</td>
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<td>Apr 13</td>
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<td>Apr 20</td>
<td><strong>Technology</strong> - School Visit 5</td>
<td>Technology Presentations</td>
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<td>Date</td>
<td>Topics</td>
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<td>Apr 27</td>
<td>Technology</td>
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<td>Videodiscs</td>
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<td>Great Ocean Rescue</td>
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<td><a href="http://www.whyville.net">www.whyville.net</a> - adolescent girls</td>
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<td><a href="http://www.fsu.edu/~imsp">http://www.fsu.edu/~imsp</a></td>
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May 4 Reading Day - no class, or snow makeup day

May 11 Technology

Technology Purchasing

* (Due dates for in progress assignments)

** Readings are found listed at the front of the syllabus and online under teacher resources at the CREST website ([http://gse.gmu.edu/centersoffices/crest/index.html](http://gse.gmu.edu/centersoffices/crest/index.html)).