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**Secondary School Science Methods (5-12)**  
*The Evergreen State College*

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***HOW CAN I CREATE, IMPLEMENT, AND SUPPORT MEANINGFUL  
SCIENCE LEARNING OPPORTUNITIES FOR ALL MY STUDENTS?***

This essential question guides the thinking and learning activities in which you will engage throughout this course. Through readings, science investigations, dialogue, being a student of your students, and engaging in the work of a teacher, we will all deepen our understandings of:

- Science education goals and standards, including Washington State Essential Academic Learning Requirements and the National Science Education Standards.
- The nature of science.
- Current thinking about science teaching and learning.
- How children learn.
- How to assess students' understandings in order to help all children progress toward scientific literacy.
- How to prepare meaningful and safe science instruction for diverse student populations.
- How to become a reflective practitioner in order to constantly grow and improve teaching and learning.

Children are natural observers and questioners, and science tends to be one of their favorite classroom experiences. But by the time they reach secondary science classes, many students have been turned off to science. They equate it with memorization of words and ideas, test taking, and canned experiments. Secondary teachers need to reinvigorate students' curiosity and intellectual honesty. By connecting classroom activities to their questions and observations, teachers can provide experiences which help students develop an understanding of their world and the interconnections amongst its many components. Unfortunately, science is often given low priority in the elementary classroom for a variety of reasons. Yet scientific literacy is essential in today's world. Teachers must be willing to explore scientific concepts with their students. Let your students' discoveries and questions excite you!

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<sup>1</sup> *Adapted from Secondary Science Methods syllabus by Dr. Anita Lenges.*

**Required Texts:**

How Students Learn: Science in the Classroom. M. Suzanne Donovan and John D. Bransford, *editors*, Committee on How People Learn: A Targeted Report for Teachers, National Research Council

This text is downloadable free online. The bookstore would not order it since you could get it for free. However, you can purchase this book online by following the “read” buttons.

<http://lab.nap.edu/nap-cgi/discover.cgi?term=How+students+learn+science>

**NEXT TIME: Order Driver et al (1994) “Making sense of secondary science” Useful resource for exploring students’ conceptions” Students can then look up resources using this as a tool**

**Recommended membership:**

Join the National Science Teachers Association!! Check it out online. You can get a student membership with one journal at a discounted price. This is an organization you should plan to join and maintain throughout your career. You will get a journal appropriate to the grade level you teach. There are online resources. You should plan to attend regional and national conferences whenever possible. Networking is important!

**Other Required Readings:**

Cobern, W. (1994). Worldview theory and conceptual change in science education. *Paper presented at the 1994 annual meeting of the national Associate for Research in Science Teaching*, Anaheim, Ca.

Fellows, N. (1994). A window into thinking: Using student writing to understand conceptual change in science learning. *Journal of Research in Science Teaching* 31(9), 985-1001.

Lederman, N., & Lederman, J. (2004). Twenty-four, Forty-two, and I love you: Keeping it complex. *Harvard Educational Review*, 61(1), 1-24. (This is available in full text from the TESC library.)

Simpson, D. (1997) Collaborative Conversations: Strategies for engaging students in productive dialogues, *The Science Teacher* p. 40-43

van Zee, E. (1997). Analysis of a student-generated inquiry discussion about the moon. *Presented at the AAAS meeting 1997*.

Vosniadou, S., Ioannides, C., Dimitrakopoulou, A., Papademetriou, E. (2001). Designing learning environments to promote conceptual change in science. *Learning and Instruction* 11, 381-419.

**The following is available online:**

Office of the Superintendent of Public Instruction. (2005). Science Essential Academic Learning Requirements: K-10 Grade Level Expectations: A new level of specificity. Olympia, WA: OSPI. See also [www.k12.wa.us](http://www.k12.wa.us)

This publication from the Northwest Regional Education Laboratory (NWREL) may be **read online or downloaded** and printed from:

<http://www.nwrel.org/msec/resources/justgood.html#inquiry>

**Select** *Inquiry Strategies for Science and Mathematics Learning: It's Just Good Teaching*

**Select** *Science and Mathematics for All Students: It's Just Good Teaching*

### Websites you might find interesting:

There are a million science-related websites! Some are great, some are awful, and many are in-between. In the meantime, these are exceptionally useful:

<http://www.nsta.org> If you join NSTA this site becomes even more rich.

<http://www.exploratorium.edu/IFI/index.html> The Exploratorium has a plethora of sites related to inquiry – you'll have to browse!

<http://www.billnye.com> Need I say more?

<http://www.grossology.org> The science of gross things . . . intermediate and middle-schoolers love this.

<http://www.lhsgems.org/gemsguides.html> Connects science concepts from GEMS units to children's literature and trade books.

<http://www.fs.fed.us/gpnf/volcanocams/msh/> The Mt. St. Helens volcano cam!

American Association for the Advancement of Science. (1993). *Benchmarks for Science Literacy*. New York: Oxford University Press.

<http://www.project2061.org/publications/bsl/online/bolintro.htm?jsRedirect&txtRef=>

Also, you might want to check out the OSPI site:

<http://www.ospi.wednet.edu>

#### Evolution:

State science tests differ greatly in what they expect students to know about evolution, with some asking no questions about the theory and others including more than a dozen items related to it, an *Education Week* review has found.

Get more information on states' treatment of evolution in the classroom from the EPE Research Center brief, "[Evolution in State Science Education Standards.](#)" (Adobe Acrobat Reader required.)

<http://www.nces.org> If you are interested in the Intelligent Design controversy, read here.

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## Course Requirements

Readings should be **completed by the date on which they are listed**. There are times when you may choose to jigsaw articles. Let's have ongoing conversations about how to best support your learning.

	Date (Tuesdays)	Focus Questions	Reading Assignment	Other Assignments
Week 1	April 2nd	What is the Nature of Science? What is the realm of science in Washington state? What's the work of a public school science teacher in the 21 <sup>st</sup>	<p><b>1. What is the work of a public school science teacher in the 21<sup>st</sup> century?</b></p> <ul style="list-style-type: none"> <li>• How would <u>you</u> address this question as scientist and community member?</li> <li>• Now consider how Washington State would answer this question by examining:               <ul style="list-style-type: none"> <li>- the overview of the new science standards (p1-11):  <a href="http://www.k12.wa.us/Science/pubdocs/WAScienceStandards.pdf">http://www.k12.wa.us/Science/pubdocs/WAScienceStandards.pdf</a></li> </ul> </li> </ul> <p><b>2. What does becoming a scientist and doing science entail?</b></p> <ul style="list-style-type: none"> <li>• How did you develop your knowledge and skills in science? How was instruction organized to support and develop your skills as a scientist?</li> <li>• Given your experience, what would you say is involved in supporting students becoming more knowledgeable and skillful as a scientist?</li> <li>• Consider how Washington State would address this question by examining overview of the new science standards?</li> </ul> <p><b>SELF ASSESS YOUR KNOWLEDGE &amp; SKILL FOR TEACHING SCIENCE IN WASHINGTON.</b></p> <p><b>Self assess yourself on the Science Standards for the grades and areas of science that you will be teaching.</b> Pay particular attention to the verbs (i.e. the ways in which students need to be able to reason with and engage the knowledge or skill)</p> <p><u>What does self assess mean?</u> List and evaluate your where your knowledge and skills are in EACH of these areas, how you gauge your knowledge/skill level, and ways in which you'd need to refine your knowledge/skills</p>	

Week 2	April 9th		<p><b>Please read:</b></p> <ul style="list-style-type: none"> <li>• How People Learn Chs. 1 &amp; 9</li> <li>• Quality Questioning Ch 1,2</li> </ul> <p><b>Bring:</b> Science Standards</p> <p><b>Take the WASL from the WASL released download for grades 8 and 10 and bring it with you</b> (This document is a huge number of pages, so be creative – consider bringing them electronically on a laptop)</p>	<p>Talk with your cooperating teacher about what will teach during week 6. (This may be impossible for him/her to do – so keep probing each week. The earlier you know, the earlier you can begin to prepare.)</p> <p>Also, try to get a copy of the teacher text (or at least student text) that you can take home.</p>
Week 3	<i>organize alternative meeting time for this week!</i>	Students' prior knowledge: cognitive constructs, philosophical orientation, and conceptual change	<p><b>Please read:</b></p> <ul style="list-style-type: none"> <li>• Duckworth (1991)</li> <li>• Coburn (1994) AERA paper: This article that challenges the framework of conceptual change</li> <li>• Quality Questioning ch 3</li> </ul> <p><b>Practice Teaching Group A</b></p>	<b>Subject matter biography due</b>
Week 4	April 23 <sup>th</sup>	How can you use questions, dialogue and other formative assessment strategies to elicit children's understandings and inform your teaching?	<p><b>Be prepared to share student interviews (and turn in your write-ups) today.</b></p> <p><b>Please read:</b></p> <ul style="list-style-type: none"> <li>• Vosniadou et al (2001)</li> <li>• Fellows (1994)</li> <li>• Choose/find article about students' conceptions. (See assignment later in syllabus: Reading article that uncovers students' conceptions)</li> </ul> <p>(Creating pre-assessments for lessons: discuss in relation to your curriculum projects)</p> <p><b>Practice Teaching Group B</b> <b>Revision and Critical Reflection on Lesson Group A</b></p>	<b>Diagnostic student interview</b>

Week 5	April 30 <sup>th</sup>	<p>Try out teaching and reflections. How do we see key principles in the try out teaching lessons?</p> <p>What kinds of teaching practices will make our science classrooms inclusive?</p>	<p><b>Please read:</b></p> <ul style="list-style-type: none"> <li>• HPL chapter 12.</li> <li>• “Science and math for all students.” Northwest Regional Education Laboratory (NWREL): <i>Inquiry Strategies for Science and Mathematics Learning: It’s Just Good Teaching</i>. Obtain online and read online or download and print from: <a href="http://www.nwrel.org/msec/resources/justgood.html#inquiry">http://www.nwrel.org/msec/resources/justgood.html#inquiry</a></li> <li>• Quality Questioning ch 4</li> </ul> <p><b>Revision and Critical Reflection on Lesson Group B</b></p>	
Week 6	May 7 <sup>th</sup>	<p>NO CLASS – TEACH 2-3 CLASSES IN YOUR FIELD PLACEMENTS See main syllabus for other tasks.</p>		
Week 7	May 14 <sup>th</sup>	<p>Inquiry as an instructional strategy</p> <p>Discourse that promotes scientific learning.</p>	<p><b>Please read:</b></p> <ul style="list-style-type: none"> <li>• Van Zee (1997)</li> <li>• Simpson (1997)</li> <li>• Inquiry strategies for science and mathematics learning.” Northwest Regional Education Laboratory (NWREL): <i>Inquiry Strategies for Science and Mathematics Learning: It’s Just Good Teaching</i>. Obtain online and read online or download and print from: <a href="http://www.nwrel.org/msec/resources/justgood.html#inquiry">http://www.nwrel.org/msec/resources/justgood.html#inquiry</a></li> </ul> <p><b>Make sure you have read the article you chose about students’ conceptions by today</b></p> <p><b>Practice Teaching Group A</b></p>	

Week 8	May 21 <sup>h</sup>	How might you tailor existing curricular units and lessons toward inquiry learning and the specifics of your class and your school, district, and state goals? Student question posing.	<p><b>Please read:</b></p> <ul style="list-style-type: none"> <li>• How People Learn Ch. 11</li> </ul> <p><b>Practice Teaching Group B</b> <b>Revision and Critical Reflection on Lesson Group A</b></p>	Please bring science texts (preferably those that you will use in the fall, but potentially those you are using now.)
Week 9	May 28 <sup>th</sup>	Science logistics  What about “modeling?”  Overview of what we have learned.	<p>Share the results of our collective inquiry on: Safety, Materials access, organization of materials, organizational strategies of students, how to start the school year, Teaching controversial topics</p> <p><b>Revision and Critical Reflection on Lesson Group B</b></p>	

Major Assignments

B. **GET TO KNOW THE STANDARDS**

**(a) Take the most recent wasl released items** (due week 2)

Download the most recent Grades 8 & 10 WASL released items for science.

They represent a range of problem types and a range of science strands your students will be expected to know by 8<sup>th</sup> and 10<sup>th</sup> grades. Take some time to study these released items. For each item do the following:

- ☞ Solve the problem yourself as if you were taking the test
- ☞ Examine the **Percent Distribution** as students responded across the state.  
As we often do, consider what a student would have had to do to answer each question correctly and incorrectly. What is the logic behind incorrect solutions? (This will help you understand the complexities in the problems.)
- ☞ Look carefully at the Standard for the problem. What is being assessed? (This will help you see the relationship between the Standard and the WASL.)

Go through this process one test item at a time. Please take notes on your thoughts and insights as you go. We will spend some time discussing those insights in class.

C. Get to know the students

**(a) Subject matter biographies (due week 2):** Interview both yourself and 3 students from the field about your experiences, reasons for, interest and self-concepts learning second language. Notice similarities and differences between your interview and those of your students. Write up what learned from interviews and identify how the curriculum unit might address what you know about the prior knowledge, experience, and interests of your students.

Interview questions:

- How do you feel about \_\_\_\_\_?
- What kinds of experiences have you had with \_\_\_\_\_ in classes before this one?
- What do you like best about \_\_\_\_\_?
- What problems do you have with \_\_\_\_\_?
- What would make \_\_\_\_\_ especially interesting to learn?
- Is there anything else you'd like me to know about you and \_\_\_\_\_?
- When not in school, what kinds of things do you like to do \_\_\_\_\_?

**(b) Keep a journal as you continue to spend time in your classroom(s). Take notes on two key things:**

- What do the students in your classroom understand about scientific ideas? What conceptions do you hear they have. Include both what you consider accurate conceptions and inaccurate conceptions. Paying close attention to students' scientific conceptions will inform your teaching of science and the kinds of questions you pose to students to challenge their thinking.
- What do the students think about the nature of science? What kinds of comments do you hear them making about who does science, the value of science, the relationship between science and "truth."

**(c) Conduct a diagnostic science interview (Due Week 4)**

- ✓ Interview two students (one at a time) about one or two major scientific ideas. In order to identify the content of the interview think about what you want to learn about the student. Consider what you have seen students do, conceptions you notice students struggle with etc. Some possibilities

could be their theories of the phases of the moon, earthquakes, how pulleys and levers work, the water cycle, buoyancy, etc. Consider focusing on the concept that you plan to teach your 3 day lesson on, or that you plan to develop your curriculum unit on.

- ✓ Write up just one interview.

### Some ideas about talking to students

1. Tape record the conversation and keep all artifacts of the interview.
2. You do not have to pose all of the problems to a child in one sitting.
3. Before you start the interview, let the student know why you want to talk to them. Something like, *“I’m really trying to learn more about how people think about scientific ideas. I’m going to ask you a bunch of questions and I’ll ask you to explain what you were thinking about so I can learn more. This is going to help me as a teacher. It’s okay if you don’t know an answer – just tell me how you think about something. I’m not worried about whether you get the answer right. I’m really interested in how you think about the idea.”* Telling them that you’d really like their help with an assignment you have for school often helps break the ice as well.

So essentially, try to make them comfortable. Some students are not used to adults taking their scientific ideas seriously, and so they may think that if you ask them to explain, they must have done something wrong.

4. End the interview with the following kinds of questions: What do you think science is all about? Do you think scientists ask questions? What kind? What is an experiment? Do scientists do experiments? If so, why? How does a scientist decide what kind of experiment to do?

WRITE-UP (Treat each check flag ☞ as a section of the write-up; use subheadings)

You do not need to provide a complete transcript of the interview!!!!!!!!!!!!

#### ☞ **The Student**

Describe the student you plan to interview. Include information you gather about the child (grade level, age, gender, race, and academic participation). What do you know about the student’s level of understanding about the scientific concept before the interview? (Use a pseudonym for the child.)

#### ☞ **The Scientific Concept**

Briefly describe the question or task(s) you gave to the student. Briefly explain why you chose these tasks. (Pose 1-2 main tasks and follow them up with appropriate and potentially extensive probing questions.) Include students’ written work. This may include pictures, diagrams, symbolic notation.

#### ☞ **Analysis and Reflection**

Analyze the problems and tasks that helped you learn the most about the child’s scientific reasoning.

- ☞ What did the student do? (Use some verbatim comments from the student that helps clarify what the student did.)
- ☞ What does the student understand?
- ☞ What do you think the student is confused by?
- ☞ What questions would you like to ask the student now in retrospect?

#### ☞ **Reflecting on your questioning and interviewing skills**

- ✚ What is your assessment of your questioning? How well do you think you were able to elicit the students' ideas? What might you do differently next time? **Please use specific examples from your interview to answer these questions.**

**(d) Read an article that uncovers students conceptions on a topic of interest (choose article week 2; read it by week 3)**

Educational researchers have done a lot of groundwork in terms of uncovering typical student conceptions about scientific ideas. You will find, read, and summarize key ideas from an article that identifies students' scientific conceptions. These articles are useful for you as you consider teaching various concepts and units. Try to find an article that relates to the lessons you will teach during week 6. If you can't find one specific to that particular content, then at least find one from your field.

Samples of Specific References on Student Conceptions are listed below (Taken from the FACET website). They are primarily about physics. <http://www.facetinnovations.com/daisy-public-website/fihome/resources>

- Andersson, B. R., and Kaerrqvist, C. (1983). How Swedish pupils, aged 12-15 years, understand light and its properties. *European Journal of Science Education*, 5(4), 387-402.
- Camp, C., Clement, J., & et. al. (1994). Pre-conceptions in mechanics: Lessons dealing with students' conceptual difficulties. Dubuque: Kendall Hunt.
- Caramazza, A., McCloskey, M., & Green, B. (1981). Naive beliefs in "sophisticated" subjects: Misconceptions about trajectories of objects. *Cognition*, 9(2), 117-123.
- Champagne, A. B., Klopfer, L. E., & Anderson, J. (1980). Factors influencing the learning of classical mechanics. *American Journal of Physics*, 48, 1074-1079.
- Clement, J. (1982). Students' preconceptions in introductory mechanics. *American Journal of Physics*, 50(1), 66-71.
- Goldberg, F. M., and McDermott, L. C. (1986). Student difficulties in understanding image formation by a plane mirror. *The Physics Teacher*, 24(8), 472-480.
- Gunstone, R. F., White, R. T. (1981). Understanding of gravity. *Science Education*, 65, 291-299.
- Gunstone, R. F. (1987). Student understanding in mechanics: A large population survey. *American Journal of Physics*, 55(8), 691-696.
- Halloun, J. A., and Hestenes, D. (1985). Common sense concepts about motion. *American Journal of Physics*, 53, 1056-1065.
- Hestenes, D., Wells, M., & Swackhamer, G. (1992). Force concept inventory. *The Physics Teacher*, 30(3), 141-166.
- Maloney, D. P. (1985). Charged poles? *Physics Education*, 20, 310-316.
- McCloskey, M., Caramazza, A., & Green, B. (1980). Curvilinear motion in the absence of external forces: Naive beliefs about the motion of objects. *Science*, 210(5), 1139-1141.
- McCloskey, M. (1983a). Intuitive physics. *Scientific American*, 248(4), 114-122.
- McCloskey, M., and Kohl, D. (1983b). Naive physics: The curvilinear impetus principle and its role in interactions with moving objects. *Journal of Experimental Psychology*, 9, 146-156.
- McDermott, L. C., Shaffer, P. S., & Somers, M. D. (1983). Research as a guide for teaching introductory mechanics: An illustration in the context of the Atwood's machine. *American Journal of Physics*, 62(1), 46-55.
- Minstrell, J. (1982). Conceptual Development Research in the Natural Setting of the Classroom. In M. B. Rowe (Ed.), *Education for the 80's: Science* : National Education Association.
- Minstrell, J. (1982). Explaining the "at rest" condition of an object. *The Physics Teacher*, 20, 10-14.
- Peters, P. C. (1982). Even honors students have conceptual difficulties with physics. *American Journal of Physics*, 50, 501-508.

- Rice, K., and Feher, E. (1987). Pinholes and images: Children's conceptions of light and vision I. *Science Education*, 71(4), 629-639.
- Trowbridge, D. E., and McDermott, L. C. (1980). Investigation of student understanding of the concept of velocity in one dimension. *American Journal of Physics*, 48(12), 1020-1028.
- Trowbridge, D. E., and McDermott, L. C. (1981). Investigation of student understanding of the concept of acceleration in one dimension. *American Journal of Physics*, 49, 242-253.
- Whitaker, R. J. (1983). Aristotle is not dead: Student understanding of trajectory motion. *American Journal of Physics*, 51(4), 352-357.

#### D. PRACTICE TEACHING

Over the course of the quarter you will write lesson plans, teach, critically reflect on and revise two 50 minute lessons to your colleagues. As a class we will then take time to provide peer feedback on strengths of the lessons and areas for growth; paying particular attention to how you supported student inquiry and thinking.

The week you or your group is teaching:

- (i) Sketch out a 5 day unit of which you will teach one 50 minute lesson. The outline should include a big idea in science and the relevant science standards students will learn something about in the unit.
- (ii) Write a clear four-column lesson plan that includes enough detail so that your reader can create the lesson in his or her imagination, even without actually experiencing it. In addition the lesson plan should include (a) a clear learning objective; (b) the specific Science standard you are working with in this lesson; and (c) the concept/big idea your lesson is targeting. Finally, (d) make sure the fourth column includes specific actions and questions you anticipate being necessary during the lesson.
- (iii) Plan and conduct a formative assessment that provides you information on what the student is learning, and what your next steps would be. (Use Stiggins to help you develop this assessment).
- (iv) Write a paragraph that explains: 1.) How your lesson invites student thinking and what you will do to support that thinking; 2) elements and strategies for ensuring lab safety that you need to attend to (talk to your teachers to inform this question)

The week after you have taught a lesson each of you should individually:

- (i) Write a critical reflection and revision of the lesson in which you do examine the strengths and areas for growth of the lesson in light of your learning objectives. Use the following guiding questions to inform your reflection:
  - Was I able to anticipate what students would do and say?
  - Were my interventions effective?
  - What ideas did students have that I did not anticipate?
  - In what ways did the lesson plan help my teaching of the lesson?
  - What do evidence do I have of student learning?
  - What evidence do I have that content was both accessible and rigorous?
  - What changes do I need to make to make the strategy accessible for all students?

- (ii) Revise the 4 column lesson plan in light of your experience and peer feedback.
- (iii) Use the assessment data to identify a next step, were you to continue on from here, with a lesson. (i.e. what have you learned from your students that they understand, and that they need to understand better?)

Hand in your critical reflection and revision to Sonja on Friday mornings

## E. LEARN ABOUT LAB SAFETY, CLASSROOM MANAGEMENT, and CONTROVERSY

As you continue your thursday observations, talk with science teachers in the building about the following six topics.

- **Safety:** What kinds of things do they do to create a safe environment while working with equipment? How do they teach that to students?
- **Materials access:** Science classrooms have a lot of stuff. That includes permanent equipment as well as consumables (perishables). Where do they come from? Who orders them? How long in advance do they need to be ordered? What kind of budgets do the teachers have?
- **Materials organization:** Learn about the organization of materials in the science department. What works? What doesn't? Materials organization can really support your work as a science teacher, or create an abyss of time consumption.
- **Organizing students:** Given that group work can be a large part of the science classroom, how do teachers create and keep track of groups and group work? Are there systems for individual responsibility as well as group responsibility? (Think about what Arends talked about when assigning group tasks.)
- **Starting the school year:** What do teachers do on the first few days in a science classroom to establish a culture of inquiry and a safe environment? What ideas do you have and what kinds of modifications will you want to make when you start teaching?
- **Teaching controversial topics:** What challenges do the teachers face when teaching various topics, such as Evolution, or asking students to dissect animals?

Also, conduct an independent investigation on Teaching Controversial topics. You might start with the following link from NSTA: <http://www.nsta.org/evresources> . Use what you are learning to inform your preparations and critical reflections through out the quarter.

## F. WHAT SHOULD THE ROLE OF TECHNOLOGY BE IN MY CLASSROOM? (due week 10)

As I'm sure you know, children and adolescents today are immersed in an electronically based, technology-driven world. Most of your students will have never known a world without television, CDs, DVDs, TIVOs, iPods, podcasting, cell phones, texting, the Internet, instant messaging, Xboxes, PlayStations, and Wiis. Increasingly, articles are being written about the pros and cons of electronic media in the lives of children. Do uses of these media change children's brains? Do they affect reading and writing abilities? Creativity? Levels of activity and ability to sustain attention? What are the effects of the digital divide? What is the role of technology in the science classroom? Should teachers use computer games, web-based resources, and Internet research to support student learning? How are students being taught to find, evaluate, and make appropriate uses of Internet resources? These are all questions you will need to answer for yourself. To start you in that process, you will complete a technology resource notebook that includes the following:

1. Survey of the kinds of technology teachers & students use in the science classrooms in each of your colleagues' schools.

2. Use the internet to learn about other ways teachers and students use technology in science classrooms in public schools around the country.
3. Write summaries and critiques of two or three articles or websites you find about innovative uses of technology for science classrooms.
4. Summaries and critical reviews of 4-5 potentially useful science web resources.
5. Summaries (with your responses) of any articles you find about when it is developmentally appropriate to use computer-based or web-based technologies with children and adolescents
6. **Final technology reflection:** What technology tools do you need to learn as part of your skills in teaching science in 21<sup>st</sup> century public school classrooms?

As you peruse the websites, use the following questions to guide your critiques. These are the same questions that would be helpful for your students to answer as they make use of electronic resources. These questions were adapted from *The Power of Questions* (pages 55-56) by Beverly Falk and Megan Blumenreich. Your critiques should answer these questions and then contain your conclusions about the relative strengths, weaknesses, and potential usefulness of the sites.

1. Who is the author of the site? If the author is one person, what are that person's credentials? If the author is an organization, check it out in *the Encyclopedia of Associations*. Is there an address or email address given? Why does it matter to know this information?
2. What country or state does this website come from? Why does it matter?
3. How objective is the website? What is its purpose – to inform you, convince you of a point of view, sell you a product or service, amuse or entertain you?
4. How current is the website's content? Has it been updated to reflect current news and trends? Check the date of creation, the last update, and if the links are up-to-date.
5. What is the intended audience for the site? At what age or reading level is it aimed?
6. How is the site organized? Is it organized logically? Is it well designed? Is it easy to navigate? Does it overwhelm you with ads?
7. Does it represent any biases against gender, ethnicities, religions, sexual orientation, gender?
8. What are the underlying assumptions about how learning occurs? In terms of literacy instruction, what model does the site seem to represent?