March 2008

Dear colleagues,

After a presentation last semester I heard one of my friends comment to another, "You are very teacherly." "Hey!! That's not very flattering," the second looked put off. The peculiar thing was that the friend who felt slighted wants to be an educator. Still, in her head being "teacherly" had a negative connotation. It drew to her mind a person standing in front of a class speaking in a half-dry, condescending sing-song voice, spoon-feeding students information.

As an educator I want to break the stereotypical teacher mold. I want to present students with problems that stimulate their imaginations and whet their curiosity. I want students to feel responsible for and invested in their own science education, not as though they are opening their mouth for a spoonful of goopy banana. I've attempted to accomplish this in my plate tectonics curriculum. I have thoroughly enjoyed and grown from the perspectives all of you have brought to class this semester and am looking forward to your feedback in hope that it will help me strengthen my abilities as a curriculum designer. Please let the comments flow freely and honestly.

My Bottom Lines

The inclination to spoon feed students seems entrenched in our society's world view. According to this view, students are not mature enough or experienced enough to understand broad concepts. Therefore, we break things down for them into bite-sized pieces. This, in turn, leads to dull, step-wise teaching. Unfortunately, this approach to education robs students of the opportunity to experience the complexity of the world firsthand and of the joy that comes with delving into this rich environment. To avoid spoon feeding, I've tried to create a curriculum that meets all of the following criteria.

- ✓ **Holistic**

I think it's important for all curricula to begin with the big picture. In discussions during our Foundations of Science and EE and Curriculum Design classes this semester, many of us have lamented the overemphasis on memorization of discrete facts. Perhaps it is idealistic, but I don't think teachers start out with the intent to have students blindly memorize facts. Rather, this emphasis is a side effect of starting with the details to help students understand the whole. Unfortunately, many students are frustrated by minutiae before reaching that understanding or lack a sense of purpose because they don't know what they're working toward.

My attempts to be true to this bottom line:

- I have structured the curriculum around a major question: Where would the earth be stable enough to store nuclear waste for the next 100,000 years?

- I started the unit off by introducing students to major geologic phenomena and asking them to think about why these occur, not with the details such as the layers of the earth and their properties.
- I tried to sequence the unit so that topics would come up organically. For example, after learning about convection, students might wonder what is inside the earth that convects.

✓ Interconnected

One of my main criticisms of our current science education system is that it does not help students understand the interconnectedness of the earth's systems. In this and all curricula, I hope to help students see that our decisions cannot be made within a vacuum; they must consider the entire system.

My attempts to be true to this bottom line:

- The problem of where to store nuclear energy does not seem immediately related to geologic activity. Further investigation reveals that it is related in important ways, demonstrating interconnectedness.
- I will also facilitate the unit to help students make connections between nuclear waste disposal and social justice issues.

✓ Differentiated

The human brain gathers knowledge in a multitude of ways. As I see it, the greater the number of cognitive pathways we send knowledge down, the greater our chances we have of activating the brain.

My attempts to be true to this bottom line:

- My curriculum utilizes a variety of teaching and learning methods- lecture, experimentation, readings, discussion, audiovisuals, role playing, modeling, and student presentations.
- The challenge board provides students with choice in proving what they know.
- I assess students on a variety of things throughout: their contributions to debate, written lab reports, graphics, models, and journaling. The final assessment incorporates a number of these.

✓ Applied

A common complaint among students is, "Why are we learning this? I'll never be able to use this." I think it is our job as teachers to show students why something is important and how the knowledge we are building in our classes can affect their lives and the world. This can be accomplished by applying concepts to solve problems in students' communities, either hypothetically or actually.

My attempts to be true to this bottom line:

- Nuclear waste storage is a pressing problem. We won't solve it in my class, but students will begin to consider it and to consider it in a constructive way. I hope they will also come to understand that geologists are used in a variety of capacities in solving everyday problems.
- Through videos and testimonials I've demonstrated how geologic phenomena can impact human lives.

✓ **Fun & Engaging**

My worst nightmare is a classroom in which students are actively engaged in trying to prop their eyelids open. I want to have a class that stimulates the inherent curiosity of my students, that gets them pumped up about exploring the world they live in. That's what science is about! If I fail to do this, I fail my students.

My attempts to be true to this bottom line:

- I've used live footage of geologic mayhem.
- Students will engage in debate with their peers.
- I incorporated labs that allow students to discover concepts on their own.
- Students will be manipulating real data to draw conclusions.
- They get to play with clay and other building materials to make futuristic models of the earth.

Drawing From a Deep Pool of Ideas

The idea of trying to meet all of my bottom lines *alone* is disheartening. Fortunately, I won't ever need to. There will never be a shortage of other teachers to turn to for good ol' fashioned brainstorming sessions or a dearth of curricula resources online. For this instance, I drew inspiration from a few different sources: a classroom observation, teacher and student interviews, and a review of various plate tectonic curricula.

A. Seventh Grade Science Classroom Observation

Each class commenced with what the teacher introduced as "group reading", but was actually comprised of students staring awkwardly at each other before reading silently to themselves. From the reading the students were supposed to label a diagram of an egg. After the time was up, the teacher went over the worksheet rapidly and didactically, clapped her hands twice and said, "NOW we are going to dissect raw eggs".

At this point, the mood of the classroom altered drastically. Students huddled around eggs, painstakingly peeling off the shells so as not to break the inner membrane. Each group went about the dissection differently- some peeled half of the shell back creating a cross-section; others scrambled their eggs; still others separated each part of

the egg, yolk from white and white from shell. Then, at a soft word the children were lining their dissected eggs up on the counter and finding their seats.

The groups spent the last 20 minutes plotting out an osmosis experiment they'd conduct the next day. In this experiment they would place shell-less eggs in different substances to see whether they would gain or lose water through osmosis. The students were charged with choosing what liquids to put the eggs in, listing out the variables they'd need to control and developing a hypothesis. I listened in on one group's conversation as they wrote their hypothesis. "So, what do you think your egg will do?" one kid asked another. "I, dunno, I guess it'll lose weight," she replied. "Miss Fletcher said we have to say why," another student supplied. "Well, cause soda has bubbles," the first girl responded. Because the teacher wasn't present when this was said, I realized she wouldn't know one of her students thought osmotic action depended on how bubbly something was. Then, as if by some secret signal all of the students grabbed their bags and showed Miss Fletcher that they'd filled in their assignment books with, "Finish Lab Plan".

As they filed out, I glanced at the clock and realized only 50 minutes had passed! I sat in my swivel chair, stunned at how much Miss Fletcher had done with her students in an hour and not sure what to think. I admired how she had kept the students engaged by switching between algorithmic, heuristic, and algor-heuristic activities. The students never seemed bored or off-task, a challenging feat with a class full of seventh graders. Frequently switching activities had another important benefit; it reached a variety of different learning styles. Finally, I admired the exploratory nature of the class. At one point Miss Fletcher actually squealed in delight when one group found the "germinal disk", a tiny part of the egg where the female's genetic material is stored. The class was truly exploring and Miss Fletcher was placing the "IT" between herself and her students.

On the other hand, I did not see how a "Parts of an Egg" fill-in-the-blank worksheet or an egg dissection helped students understand osmosis, which was the focus of the unit. If the students had been learning about reproduction or avian life, perhaps this would have made sense. However, since this was not the focus of the unit, it seemed like she wasted 30 minutes of her 50 minute class. Ironically, she later told me that she never felt like she had enough time to cover the necessary material.

I took three main lessons away from this observation. First, teaching from different places along the algor-heuristic continuum will keep students engaged and will minimize behavior issues. Second, it is important to always keep the theme of your lesson in mind when planning out lessons lest you stray from it. Third, being present when students are making hypotheses and developing theories is essential. If a teacher is tidying papers on her desk when a student proposes that bubbles affect osmosis, she may not later understand the difficulty her student has in understanding the true reasons. In the

curriculum I have designed, I strove to mix up learning activities, to keep my conceptual goal in mind at all times, and to embed assessment.

B. Teacher and Student Interviews

The interviews I conducted were peppered with a few vital nuggets that I have tried to incorporate into this unit. I found the student interview with Anne particularly insightful.

- ✓ **Depth not Breadth**

Anne said she wished that the classes were smaller so that the teacher would have time to go into more depth with each concept. She really liked units that were review from her younger years because she felt that she got to probe deeper into the things that fascinated her, rather than remaining at a surface level of understanding. If there was more time per unit, she felt, they would be able to go deeper. It struck me that it is my role as a future teacher to advocate for quality in our schools rather than quantity.

- ✓ **Teacher-Student Dialogue**

"Teachers should talk WITH students, not AT them," Anne advised. This goes along with my prior assertion that students should not have a teacher that patronizes them in tone or by oversimplifying concepts.

- ✓ **Thinking Work vs. Busy Work**

Students are fully aware of when a teacher is giving them work to keep them busy versus to stimulate their minds. Anne expressed this to me in her interview, saying, "Good homework makes you think." She dislikes when teachers give them study guides with fill-in the blanks or other meaningless work. This thought was mirrored by both teachers I interviewed- they agreed that crossword puzzles and their ilk were a waste of time. Whenever I have assigned homework in this unit I have tried to make it something meaningful.

C. Curriculum Review

Honestly, I did not find any one curriculum on plate tectonics that I was completely satisifed with. Most of the curricula I reviewed took the spoon-feeding approach that I denounced earlier in this letter. Even these were valuable, however, as I drew ideas for particular activities or audiovisuals from them. One curriculum resource stood out from the others, however: My Plate Tectonics Science Box. (www.mysciencebox.org) This curriculum, created by Irene Salter, started the unit by having students gather real earthquake data online, then plotting that data on a classroom wall map. Students then use this newly created seismology map to pick out patterns. As the unit progresses, evidence supporting the theory of plate tectonics accumulates. Students add data on volcanoes to the map and sketch in the mid-ocean ridges, they go on a simulated walk to the center of the earth, they complete a lab that explains convection, they examine the maps they've made to infer the direction of plate movement, and they create a model of a divergent plate boundary.

What I liked about this curriculum:

- It started with the big ideas (quakes, volcanoes) and got progressively more detailed.
- It allowed students to gather their own evidence and apply it to figuring out why these geologic phenomena occur and, eventually, to discover the theory of plate tectonics on their own.
- It used a variety of methods such as lecture, experimentation, and modeling.

What I disliked

- It was not applied to solving "real-world" problems.
- It did not include an activity to elicit students' initial theories.
- The experiments were step-wise.
- Much of the info. was given to students before the labs or data gathering, sort of negating the point.

In my curriculum I tried to incorporate the strengths and avoid the weaknesses. Let me know if I succeeded!

Convening Session POA

Persistent Problems

Throughout the designing process a few difficulties persisted.

a. What can I do to keep the overarching question of the unit alive?

I had difficulties intertwining the big question I posed effectively throughout the unit. I'd like it to be more prevalent than it is. How could I keep it in the forefront of students' minds? How can I prevent them from getting tired of the question after awhile? Essentially, what can I do to keep the overarching question of the unit alive?

b. Short of changing my overarching question, how can I make this curriculum more place-based?

Developing the overarching question was one of the most challenging aspects of this project for me. I chose to focus on nuclear waste storage because it is a pressing issue worldwide and one that my students will be confronted with in their adulthood. I also chose it to help students understand what sort of problems geologists are involved in solving. However, once settled on the question, I could not figure out how to incorporate learning about the area's particular geology. If I keep my overarching question, what are some things I can do to make this curriculum more place-based?

c. **What are some additional things that I could do to work from the whole to the parts?**

I found it difficult to work from the whole to the parts without sacrificing understanding of the parts. However, as I said earlier, I believe it is very important to me to approach curriculum in a holistic fashion. I will be asking you to brainstorm additional ways to work from the whole to the parts.

Here's How It'll Work...

- Q&A to clarify questions about the curriculum (5 minutes)
- Filtering the Curriculum Through My Bottom Lines (10 minutes)

  Each person will pull a piece of paper from a hat with one of my bottom lines on it and will write additional ideas for implementing them. Then you'll blindly swap and add to another's comments.
- Small Group Discussions re: Persistent Problems (20 minutes)

  As you're reading through my curriculum materials, please keep the questions I've posed above in mind. I will send each of you an e-mail by Wednesday night asking you to rank the questions above in the order from the one that interests you most to the one that interests you least. For example, if I was interested in c most and b least, I'd write c- a-b. I'll use the rankings you send me to place you in small discussion groups. If you have a laptop, please bring it to class so that you can take notes and send them to me. Thanks!
- Big Group Discussion- Greatest Strengths and Weaknesses of the Curriculum (25 minutes)

I'm looking forward to reading/hearing your ideas. Please be open; I won't be offended. If you have any questions about the curriculum or about how the convening session will work, feel free to e-mail me!