

Inquire How to Inspire and Create a Desire: the essential ingredients of a successful science inquiry unit.

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My Teaching Context

I am a PDS (Professional Development School) intern in the State College Area School District. Through this program, I have been actively involved within the classroom for one-hundred and eighty five days, where I have observed, taught, attended staff meetings, faculty meetings, conferences, and IEP meetings. Along with my classroom experience, I was also involved in methods courses.

As a PDS intern, I was placed in a fifth grade classroom at Boalsburg Elementary School. Boalsburg Elementary is only made up of two grades, fourth and fifth, totaling six classrooms altogether. It is a very old, small building with large classrooms and a large playground. The size of the building contributes to the formation of a very close-knit community inside.

My class was made up of nineteen students until two weeks ago when another student arrived in our classroom. There are now eleven boys and nine girls. Two students participate in learning support and one student is Title I in reading. My class is made up of many unique individual personalities and learners who contribute to the chemistry that is found in the classroom. The students have built a very strong

cooperative spirit over the past year which encourages many learning experiences among groups.

Why I Chose Science Inquiry

When I first approached this inquiry project, I knew that I wanted to focus my attention on science within the classroom. We had just finished with our DI block and pre-student teaching where we were learning how to teach more conceptually, especially

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in math and science. I decided that science inquiry was an area that I wanted to explore further to witness the effects it had on students and their understandings. In our DI block, we were presented with different inquiry activities where we took on the role of the students. Also, as part of our student teaching, we were required to teach a three-day science inquiry unit. Through experimenting with different inquiry lessons as a student and teacher, I was slowly seeing the great effects inquiry had on the learning process.

Literature and Research

“Today, educators and researchers understand that most people learn best through personal experience and by connecting new information to what they already believe or know. Excellent teaching and quality textbooks aren’t enough. Students need to personally construct their own knowledge by posing questions, planning investigations, conducting their own experiments, and analyzing and communicating their findings. In short, students construct their own knowledge by actively taking charge of their learning-one of the primary tenets of inquiry” (Jarrett 6).

Another research book focusing on learning science titled, Taking the Plunge, states,

“School science activities must take into account the way children learn at the primary level that is with thinking and doing closely related. Understanding depends on children working things out for themselves. This is not the same as saying that everything has to be discovered from scratch, but it does mean that children should be satisfied that the ideas

they accept fit the evidence as far as they can tell. Some of these ideas may have been developed by the children themselves, offered by other children, by their teacher, or found in a book” (Harlen 5).

Knowing the great effects that inquiry can have on students and their learning made it even more appealing to inquire about. Even though this topic has been researched greatly over the past decade, I knew to truly understand the elements of

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inquiry, I would have to experience the successes and failures first hand. According to Connect Magazine,

“When students are doing inquiry-based science, an observer will see that: Children view themselves as scientists in the process of learning, accept “Invitation to learn” and readily engage in the exploration process, plan and carry out investigations, communicate using a variety of methods, propose explanations and solutions, build a store of concepts, raise questions, use observations, and critique their science practices” (Synergy Learning 13).

How I Set Up My Inquiry Project

Not only did I want to learn about the ideas I had read about in my science methods course, I wanted to explore how writing, drawing, and discussion affected the students’ understanding. To see the effects inquiry had on the students, I shaped the curriculum to become more inquiry-based to fit the purpose of my inquiry project. I did not completely erase the entire curriculum but instead used some of the more inquiry-based lessons, along with some of my own inquiry-based lessons to hit the main concepts found within the curriculum. (See Appendix D) I took out a number of lessons because I felt it more beneficial for quality and not quantity. Also to get the students to feel like scientists, I prepared business cards with their names, profession (Geologist), and

objectives of study for the unit. Once they mastered a new concept within the unit, I would sign beside that concept which would signify that they had become an expert in that certain field. I hoped that this would create a desire to learn the information and help to inspire the inquiry process that real scientists participate in every day.

What I started to realize as I began my planning and teaching of the geology unit was that a successful inquiry unit was a lot more than just planning good inquiry lessons.

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It needed a lot of time and strategy. Some students had never been presented with lessons that were very inquiry-based and getting some of those students to think on a higher level was a great challenge. Another challenge was teaching the concept of providing evidence to back up any claim or “understandings”. Not only were the students new with creating their own understandings but I, as a new teacher, was taking on the challenge of figuring out exactly how to get my students to think and use the inquiry-based experiments to increase their comprehension. It is also said by Wynne Harlen, “that teachers often times look for complex definitions and correct vocabulary from students when addressing certain issues when in reality childrens’ views are often different from scientists’ views but to children they are sensible, useful views.”(76) As a new teacher, I felt one of my challenges throughout the year lay in determining the knowledge base that fifth graders possessed. When I first started inquiring about this topic, my initial research question was, **“Can I enhance my students understanding and ownership of science concepts through the use of inquiry and writing?”** Other questions that I pondered were:

- What are the benefits of teaching a lesson that is more inquiry-based?

- How do I know the students understand the lesson and the materials?
- How can keeping a journal or writing about their understandings help make their understandings clearer?
- Can writing help connect material over the course of the lesson?
- Can writing allow the students to be more in control of their learning?

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- Could having the students write more using evidence to back up what they are saying help them to articulate their answers when it comes time for the PSSA?
- Can students explain their understandings better through writing than through talking and discussions?

I had begun my inquiry project with the idea that writing, drawing, and discussion could help a student to understand the concepts in more detail. What I started to realize at the end of my inquiry project was that writing and drawing were great assessment tools. Through their writing, drawings, and discussions, I was better able to see how their conceptual understandings were developing and the effects that inquiry-based science lessons were having on their thinking abilities. It was brought to my attention that if the student had no conceptual understanding, it was hard for them to explain any sort of idea on paper. I believe that writing can help the students whose thoughts are disorganized to organize those facts. There has to be an understanding to build upon for writing and drawing to really help develop a student's understandings. I also realized that without enough time to write, draw, and discuss, students' understandings do not have time to process.

“Students need to interact with their peers and the teacher on inquiry-based investigations. They need ample opportunities to discuss their own ideas, confer and debate with their classmates, then to have time to reflect on the feedback they’ve received, to make adjustments, and to retry their experiment or activity” (Jarrett 11).

As the project went along, I started seeing the whole picture of what a successful science inquiry project would look like. I realized I was missing all the minor details that contributed to the success or failure of each lesson as well as the unit as a whole. I felt

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that because I was experimenting with the process of teaching inquiry, I needed to focus on the overall picture of a successful inquiry unit.

My inquiry question finally came to be: What elements are needed for teaching a successful inquiry-based science unit?

My sub-questions remained the same from the beginning of my inquiry.

Data Collection

The students’ journals were the most crucial part of my data collection. The journal consisted of a purple folder where the students placed all of their worksheets and conclusions within. They were set up in different ways to allow me to observe how a structured worksheet affected student response compared to a blank sheet of paper that would allow students to write and organize and structure their own understandings. I also had my own journal containing the amount of time we had for discussions, writing, and some of the comments the students had about the lesson we did for that day. I also gave the students a survey of their thoughts on the Geology unit: what they enjoyed, didn’t enjoy, their understandings and what helped with their understandings. Interviewing the students on video was also part of my data collection as I asked them questions pertaining

to their understandings and opinions. Besides my own data collection within the classroom, I was able to find numerous articles and books pertaining to inquiry within the classroom.

Analyzing Data

For the first part of my data, I analyzed the surveys from the students. Using the surveys gave me a chance to hear what the students attributed their understandings to

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and what they liked or disliked. To organize this data, I focused on one individual question at a time. Focusing on one question allowed me to sort the surveys into groups according to students' responses. Though all of the questions were fill-in-the-blanks, the students all responded in a similar manner, which allowed me to group the response into three to four different piles. After I grouped each individual question and calculated the number of students in each category, I could see what the students enjoyed and what strategies they felt helped them to understand. Students' excitement for science and their understanding of the concepts were highly contributed to the hands-on activities. They enjoyed having more freedom and choice which they felt helped to shape their learning. Discussion also weighed highly in the success of student understandings. The next piece of evidence I analyzed was the students' journals. Using the students' journals, along with my individual journal, allowed me to see the patterns where the students were able to write more freely, were aware of their task, had time for discussion, and time to write their understandings. During the lessons where time was scarce, students' answers were short, incomplete, and lacking evidence. Students' journals were also lacking understanding when discussions were not present because of the connections students

made among our discussions. (See Appendix C) I was also able to analyze from the journals that my strongest discussion leaders were the ones whose journals lacked the understandings I knew they possessed. (See Appendix C) By using my own journal, I was able to record comments that students made pertaining to the unit and the lessons. Reading over these comments allowed me to see the students' engagement outside of the classroom as well as within the classroom. (See Appendix A) Looking over my unit was

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another way I analyzed what affected the inquiry process. Different lessons triggered different results and engagement in the students which showed a direct effect on the students' motivations within the lesson. (See Appendix D) Students' least favorite part of the unit was doing research on the computer. They went through the motion of taking notes without the desire to learn. One of the students' favorite lessons was the creation/explosion of their volcanoes. After completing my data collection and analysis from my science-inquiry unit, I concluded with five claims pertaining to the elements of a successful science inquiry unit.

My claims

First Claim: Inquiry engages the students and creates a desire to inquire and learn.

Evidence: When the students were presented with a survey of the Geology unit, sixteen out of seventeen students claimed they enjoyed the unit. Their reasons for enjoying the unit were broken down accordingly: Fourteen students said it was fun, the activities were fun, and they got to do hand-on experiments by themselves, three said they have always loved science, and one said that he just didn't like the topic of Geology. (See Appendix A) I had one little girl tell me that she came to school because she wanted to see what we

were doing in science that day. I also had many students write in a survey that I gave them that they enjoyed science because they were able to do the experiments themselves and solve some of the problems on their own. On many occasions, I had students approach me asking when we were going to finish a science project we had started earlier

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in the week. This showed me that they were thinking about it and eager to continue inquiring about certain issues. I also had a little boy explain to me how he was showing his dad how tectonic plates work with pieces of ice. Not only was he talking about science outside of class, he was showing his father and then me that he understood the general concept of plate tectonics by modeling the motion. Students would often speak during class of how they were going to build their model or show their concept, outside of science class.

There was also a specific lesson during my Geology unit where I recall a few boys who find science “all right” saying, “This was the most fun thing they have ever done in science.” The desire to learn and experiment with the inquiry lessons inspired my students to do their best and really think about the projects that were presented.

“Students are provoked by what they are learning and want to learn more. By becoming immersed in ideas, students begin to pose questions or problems that drive the inquiry process. The questions or problems focus on content-but are also driven by social concerns or personally meaningful issues” (Zorfass 2).

Second Claim: Strong questioning by both the teacher and students leads to the engagement and desire to learn.

Evidence:

“Developing a question from strong knowledge base benefits young adolescents in two ways; First, it increases their chances to become self-directed learners who feel a sense of power and mastery over what they are learning. Second, when students generate a question they care about, based on immersion, the world of school becomes more authentic. School begins to model what happens in the real world of work, community, and home” (Zorfass 19).

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During one of the first lessons, students were introduced to the mystery box. Students asked questions such as, “How can we figure out what is inside?” and “Could we have a magnet to see if anything inside is magnetic?” Here, the students were able to pose questions that helped them discover evidence to support their claims. Another lesson where the great effects of student questioning and wondering occurred was during a mini-lesson focusing on the make-up of bones. Students were given bean bags to test the strength of the three hollow rolled pieces of paper. Students decided to question the strength of the bones and decided to try other weights such as dictionaries. From dictionaries, they posed a question, “Could these paper bones hold the weight of one of us?” From their inquiry and questioning, students were able to grasp the strength of the paper bones because they were able to hold eighteen dictionaries and one of their classmates. (See Appendix E) “The purpose of teachers’ questions should be to promote children’s activity and reasoning” (Harlen 44). A science inquiry lesson can be created around a single key question. During a lesson, I provided no structured worksheets for students to fill out dictating their comprehension. The only thing I equipped the students with was a white sheet of paper, where I had them write the “key” question on the top. I

told them that they would be watching a video and using sandwich models to assist their understanding that they would then have to record on the paper. From this one key question, students were able to come up with a page or two of drawings and descriptions to answer the key question.

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Third Claim: Strong inquiry based teaching incorporates several diverse strategies, such as writing, drawing, and discussion to increase the understanding of all students

Evidence: “Teachers recognize that for some students, thinking with images is more useful than thinking verbally. Visual tools can play an important role in fostering students’ deep content learning” (Zorfass 63). When I polled the students on the achievement of their understanding, thirteen said models and experiments, one said discussion, one said both models and discussions, and one said videos. If I would just use one form of stimulating the students’ understandings, I would be missing the students who feel they understood better in a different way. When I took out the element of experiments and asked the same question again, eleven said discussions and six said drawings aided in understandings.

While I was having a group discussion with the class during a lesson involving a sandwich that represented the top of the earth’s layers, I asked one child if it helped to describe the way the earth folds using the sandwich as a model. At first, he said, “Ohh, I don’t know,” but then said, “It helped my understanding because I really had to know

what was happening to be able to model it using a sandwich instead of just drawing a picture.” The science journal I made up for them consisted of a worksheet for each lesson that we completed. I took away a lot of their organizational thinking because they had to fill in the spaces versus deciding what is important to write down. (See Appendix D for samples of worksheets.) According to Judith Zorfass,

”Graphic organizers can help students comprehend, delineate, summarize, and synthesize ideas found in different sources. Some of these graphics

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can be highly formalized, and teachers can generate them to fit a specific content-learning process; Others can be created by students in response to a particular exploration” (63).

I felt that because my students were not experts in the inquiry process, the structure of my worksheets helped to bring about steps that inquiry should present. Even though most of my worksheets were structured, I had a few lessons with either no worksheet or no structure. “Ideally, science notebooks should be tools for students to grapple with scientific concepts and make sense of their understandings using recording and organizing strategies that are personally meaningful” (Fulton et al. 26-29). Analyzing the few lessons where I allowed students to organize and stimulate their own understandings on paper allowed me to observe how worksheets can hold back students whose thoughts and understandings do not coincide with my worksheets. Approaching it from another perspective, there are some students in the classroom whose ideas were greatly inspired by the structure of a worksheet. (See Appendix B)

When the lesson did not have a worksheet, there followed a presentation of the information in the form of a discussion. Within this setting, I was also able to see the understanding of the students. Through words, most of the students were verbally able to

express their understandings. The benefit I noticed from small group discussions was that I was able to probe students to explain their understanding in greater detail or probe them to explain something that was unclear. For one instance, a group of students were saying that the plates moved because of the mantle. I probed them by saying, “Why does the mantle help the continents move?” The group then responded by saying, “Because the mantle is like Oobleck and it is not a solid and not a liquid.” (See Appendix A)

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Because it is like a liquid, it is not stable and the heat and pressure cause the liquid to move around and causes the continents that sit on top of the mantle to move around as well.” (See Appendix A) I would have never received that much detail if I had not probed them further. The disadvantage of using discussion is that not every student feels comfortable participating and can become lost in the crowd.

Fourth Claim: Strong inquiry-based science lessons allow for flexibility in regards to timing and concepts.

Evidence:

“Teachers face many time constraints, but they should use available time so that students can experience concepts, not once, but periodically, in different contexts and at increasing levels of sophistication. Structure time so that students can engage in extended investigations. Students also need time to discuss and debate with one another, to try out ideas, to make mistakes, to retry experiments, and to reflect. Students also need time to work together in small groups, share their ideas in whole-class discussions, and work together and alone on a variety of tasks, including reading, experimenting, reflecting, writing, and discussing” (Jarrett 24).

During my unit, timing was one of the elements that I felt was not adequate for a successful inquiry unit. It was not as flexible as I had liked, and there were many occasions where there was not enough time for a discussion. Sometimes, there was not

even a sufficient amount of time for the students to finish their writing reflections. On the first day of my Geology unit, I had about seven minutes to discuss what the students had learned from the lesson. Within this time, I felt very rushed because I knew that I would not have a chance to revisit this lesson at another date. Because of the time constraints, my supervisor had noted that I was, at some points, telling the students things that I wanted them to discover on their own. The reasons discussions are so powerful

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sometimes are they can be lead by the students' thoughts, understandings, and questions. When the time constraint is then added to a discussion, it lends this as a pressure for a more structured conversation versus the type of intellectual discussion that could arise. There was also another lesson where students were exploring two different websites to expand their knowledge on the inside of the earth. The websites had information that was dissimilar because scientists cannot be accurate about what is inside the earth. Again, some of the students were not able to complete the questions for both sites and did not understand the inquiry that was present for the lesson. One little boy came up to me during the lesson and said, "Is there supposed to be different information on the websites?" This leads me to believe that with an adequate amount of time the students would have been able to make more connections with the questions and the information.

Geology is a topic that is hard to inquire about. It is complex. Besides models, there are not too many concrete ideas that students can relate to. One comment that I found interesting on my survey was that a student's least favorite part of the unit was learning about tectonic plates because it was a lot of research and some of the concepts that went along with them were difficult to understand.

“The problem can be introduced by using “discrepant events”-encounters that students find perplexing. Before being presented with a discrepant event, students should have a familiarity with the concepts, skills, and techniques that allow them to, first, be able to recognize a discrepant event, and, second, be able to suggest hypotheses and procedures for collecting data” (Jarrett 24).

As a teacher, it is our job not only to decide if our students have had experience with the inquiry process but where their level of understanding is at for each topic presented. The questions that need presented to simulate the students need to be more

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open so that students can stimulate their own questions. Again, topics like Geology bring about questions from students that are sometimes not testable. For instance, the question that came about most frequently from the continental drift was, “What will the earth look like in 250 million years? Will the continents be back together again?” As a class, we came to the conclusion that the continents are still moving so it is a possibility, but it was only a prediction. We cannot come up with a concrete answer. Within this science unit, the main concepts had to be inquired through research because we cannot cut open the earth and figure out how it works. Some units lend to be more hands-on because testing of a concept such as magnets or air is available to the students for experimentation.

Fifth Claim: Everyone involved in a strong inquiry-based lesson must understand the inquiry process and the roles they partake in that process.

Evidence:

“Inquiry is the set of behaviors involved in the struggle of human beings for reasonable explanations of phenomena about which they are curious.” In other words, inquiry involves activities and skills that focus on the active search for knowledge or understanding to satisfy a curiosity” (Jarrett 7).

For the first two lessons of the unit, it became clear to me that the students were not backing up their claims with evidence. They were writing things like, “because that’s what we think,” or “we made an educated guess.” After that, I presented a mini-lesson on what evidence was and why it was needed within science. Soon, the students were starting to back up their claims with evidence and data. (See Appendix B)

“Developing the ability to understand and engage in this kind of activity requires direct experience and continued practice with the processes of inquiry. Students do not come to understand inquiry simply by learning words such as “hypothesis” and “inference” or by memorizing and

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“inference” or by memorizing procedures such as “steps of the scientific method.” “Teachers need to introduce students to the fundamental element of inquiry. They must assist students to reflect on the characteristics of the process in which they are engaged” (National Research Council 14).

After I had finished the Geology unit, we moved on to the human body. During a mini-experiment, the students started to take the inquiry process into their own hands, by experimenting with ideas and testing hypotheses that I did not present to them at the beginning. This was a big step in the inquiry process because I was able to see that from participating in the Geology unit, they were starting to understand how to predict and test their wonderings without my direction.

Part of the inquiry process is getting students to write their findings and understandings down in a student-centered notebook.

“Students who have not accurately documented the growth of their plants may struggle with this task and realize the importance of using their notebooks during an investigation. Using the notebook in this manner is essential, as students use the information within it and understand the importance of documenting their work” (Fulton et al. 26-29).

As students are learning the process of inquiry, there are many ideas that can become filtered in their heads. Organizing the information can become challenging to the students because they are not familiar with inquiry.

“As you conduct lessons, you may begin to notice unique strategies that students are exploring as they work within their notebooks. Some of these strategies may be efficient, while others may appear more random. These different strategies can become more important discussions points that lead to more efficient use of the notebook” (Fulton et al. 26-29).

Inquiry can be a very powerful tool if used correctly. When students do not understand the process, the amount of control students feel comfortable taking over is

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minimal. At the beginning of my unit, some students just wanted to be told the answers. They were frustrated that the answers were not simple. As students moved through the unit, their comfort and confidence in the inquiry process started to grow and their desire to learn increased.

Implications for my Future Teaching

As a pre-service teacher, part of my goal for this inquiry project was to understand how I could assist the students to comprehend science concepts better through the use of inquiry. Using my five claims, I will focus on incorporating them into my science instruction. When trying to include each claim, I will try to start slowly, incorporating and focusing in-depth on the claims individually. Looking at my different claims, there are a lot of ideas and materials that could be focused on to produce an amazing science inquiry unit. Focusing on everything all at once will get me no further in my inquiring on science-inquiry than I was before. My main concept that I have inquired is that inquiry is very student centered. When students are the center of a

science unit, inquiry is occurring, which in turn causes students to become engaged, explore, experiment, explain, and expand. One implication that I will also take along with me is the idea of going in-depth with the concepts and not setting concrete boundaries. I will allow freedom and time for science to take place in my classroom because inquiry feeds off of time and space that it is given to soar to new heights.

Even though I may be finished with this segment of inquiry, I am left with many wonderings to inquire about such as:

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- “Does having an empty journal for the students to write their understandings facilitate understandings and ideas more than giving students a structured worksheet for every lesson?
- How much time is necessary for discussion and reflection after an inquiry-based science lesson?
- Can students lead their own science discussion and develop the same understandings as when the teacher leads the discussion?
- Is there any benefit to having a class that is highly science-centered? And does inquiry hinder or help special education students develop understandings?”

As I continue to grow as an educator, I will focus on my newly found concepts and unanswered questions. Inquiry is far more than a glance at a topic of interest or curiosity. It is a way of continually asking uncertain questions that will assist in my attempt to put together the puzzle of “Inquiry how to inspire and create a desire.”

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Appendix A **My Journal**

Day 1-Mystery Box Lesson (February 1, 2005)

- ~worked within groups
- ~discussion at end, really pushed students to think about connection to science
- ~student connection- "There is stuff inside the earth, and scientists can't get to it so they make educated guesses based on their ideas and technology which is what we did today"
- ~questions asked by students- how can we figure out what is inside? Could we have a magnet to see if anything inside is magnetic?
- ~really helped them figure out how ideas connect to science through discussion, maybe probed them too much
- ~had discussion then had them write their response after
- ~writing was minimal and rushed, very brief writing assignment

Day 2- Cupcake Lesson (February 2, 2005)

- ~individual work
- ~not much discussion before students wrote on worksheet
- ~student connection-"Scientists bore into the earth, like we did into the cupcake"
- ~hard time understanding evidence and how you need it to prove what you claim

Day 3-Technology Lesson on Inside of the Earth (February 3, 2005)

- ~students had no discussion while in process of filling out their worksheets
- ~talked to one group about understandings in detail
- ~very rushed, some students didn't even finish
- ~said, "Not a fun experiment"
- ~Student response-"Are the websites supposed to have different information on them?"
- ~Need to have a mini-lesson on what evidence is

~Also ask students to share examples and have the students think about how complete it is

Day 4 –Spinning Egg Lesson (February 7, 2005)

~discussion at beginning, “What’s inside the earth?”

~student response-“core-solid, mantle-made up of different solid and liquid stuff, crust-rock”

~had students talk within their groups about which egg was raw or hard-boiled

~14 out of 16 students guessed the right egg

~discussed about the difference in raw and hard boiled eggs and the movement, also talked about question number 1

~didn’t talk about the connection between earth and egg as whole class, just in small groups

~discussed question after they wrote it

~there was not an initial connection between our previous discussions and inside of the earth

~more connection to spinning, then what was inside of the earth and how that affected the earth’s rotation

~today really discussed what evidence was

Day 5-Oobleck

~student-“I never loved science till this year, but now I do”

~discussion at beginning on liquid, solid, gas good discussion

~some students had experience with oobleck before

~my question:”What do scientists do when they come into contact with something like this?”

~connection made to the center of the earth on how scientists make claims about what is found within the earth

~every student but two thought oobleck more like a liquid

~some students knew it was a collide because a student who was familiar with oobleck announced it out loud

Day 6-Court Case; Alfred Wegener (February 18, 2005)

~students really into scenario

~had to do a little probing and explaining why plates moved

~really demonstrated knowledge of evidence

~were able to connect everything together

~both groups that I “tried” had good information down on paper but from discussion I was able to tell they understood because I was able to probe their understanding if something was unclear

~One group of students was saying that the plates moved because of the mantle. I probed them by saying, “Why does the mantle help the continents move?” The group then responded by saying, “Because the mantle is like Oobleck and it is not a solid and not a liquid. Because it is like a liquid it is not stable and the heat and pressure causes the liquid to move around and causes the continents that sit on top of the mantle to move around as well.

- ~One student was explaining to our librarian what he learned about how the plates move and how all the continents used to be connected
- ~Student question: "What will happen in 250 million years from now?"
- ~no time for big group discussion

Day 7-Introducing Plate Tectonic Movement (February 21, 2005)

- ~showed my example and discussed what we learned last week
- ~went down to library to do research on different plate movements
- ~they will be having discussions at their different stations on the different movements
- ~new approach to discussion, student led
- ~One student having trouble understanding movement
- ~presented them with materials to build models

Day 8 (2/23/05)

- ~continue to work on plate movements
- ~"When two boys were walking into the room today, I heard them telling each other how they were going to be building their models to show plate movement
- ~This made me excited that it was something they were excited about and proud of because they were talking about it outside of science class

Day 9- 2/24/05

- ~started off creating models
- ~models were emphasized within the lesson
- ~most did a really nice job creating models
- ~most groups and students understand the basic three movements
- ~which way they moved and what can be caused by the movement
- ~what can be caused by the movements was the blurriest part of student understanding

Day 10-Mountain Formations (March 3, 2005)

- ~watched a video
- ~modeling with the sandwich layers
- ~discussion within
- ~discussion before they wrote summary
- ~asked them how models helped them to increase understanding
- ~helped visualize actual movement unlike drawing
- ~can't model unless you actually understand movement
- ~"It's like evidence" student comment

Day 11 -Volcanoes (March 15, 2005)

- ~had a lot of discussion
- ~understand that air bubbles help magma and things float and rise
- ~most students fourteen out of the eighteen predicted that cold bottle shaken up would explode
- ~whenever we came inside after demo student said, "Ohh, heat and pressure that causes it to explode"
- ~confusion about cold molecules is larger
- ~after discussion understand it was not the size of the molecules but the fact that warmer molecules move faster than cold ones, more pressure to release

Day 12-Volcanoes (March 16, 2005)

- ~had students learn about specific volcano models
 - ~we talked about why baking soda and vinegar makes an explosion (chemical reaction)
 - ~brief discussion
 - ~then ran out of time had to figure out how gas was evident in this experiment and also in a real volcano
- Student-I wasn't feeling well but I came into school to make volcanoes
- ~when students were filling out worksheet two students didn't understand where gas would be present in a real volcano

Day 13-Earthquakes (March 21, 2005)

Watched a Bill Nye the Science Guy video on Earthquakes no time for discussion

Day 14-Earthquakes (March 22, 2005)

- ~good discussion about things learned from video 10 minutes
- ~asking question: Why might a building remain standing in an earthquake while other topples over?
- ~Lots of students volunteered
- ~Better foundation, shape of building,
- ~gave new project build building that withstands earthquakes
- ~different equipment, different strategies of how to withstand earthquakes inquiry about it

Appendix B

Student Journals

Appendix C

Student Surveys

Survey Results

Why students enjoyed science?

- ~14 said that science was fun and we did a lot of fun activities and hands on activities
- ~3 always loved science (interesting)
- ~1 said he was not interested in science

What helps with understanding?

- ~13 said experiments
- ~1 said models and experiments
- ~1 said discussions

~1 said models and discussions
~1 said videos
What helped you understand between writing, drawing, and discussions?
~11 said discussions
~6 said drawings

Appendix D

Lesson Plans and Worksheets for the Unit

Appendix E

Pictures