“Can I do my research now, please?”:

The positive effects of teaching an inquiry based science unit.

Stacey Schneck

Panorama Village Elementary School, Intern

Second Grade

sas477@psu.edu

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Abstract

Can teaching an inquiry based science unit increase my students' understanding of scientific reasoning and thinking? This inquiry focuses on using inquiry based science during the Prehistoric Life and Fossils unit in a second grade classroom.

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Background Information

My Teaching Context

I have had the unique opportunity to student teach for an entire year through a professional development school, which is a partnership between The Pennsylvania State University and The State College Area School District. This opportunity has given me the experience of teaching and working with 18 second graders at Panorama Village Elementary School. In my classroom, there are ten boys and eight girls. Of these eighteen students, two are English as a second language (ESL) students, one student receives instructional support (IST) and one is in a Title I program, for extra help with reading.

What Led Me to this Inquiry?

During the fall of 2004, I was enrolled in three different teaching methods courses, one of which was Science Education 458. In this course, we were taught the inquiry method of science, and asked to teach three lessons in our classroom using the inquiry method. At this time, our students were learning about the human body during the Body, Growth, and Hygiene unit, more specifically the heart and lungs. Therefore, Heather, another second grade intern, and I, worked together to create a three day lesson plan incorporating the heart and the lungs. Our big, overarching question for the lessons was "How does exercise affect the heart and lungs?" For the lesson planning, I focused on the heart and Heather focused on the lungs. We each did our own planning for the third day of our lessons, which was a data collection day.

Throughout our lessons, we had different centers set up that allowed the students to collect data through experiments, technology and science probes. These centers gave the students hands on learning that helped them to form explanations that answered our big question. After completing this three-day teach and hearing the students' explanations using evidence from

the centers I realized how beneficial teaching science through inquiry could be. I also realized through teaching these science lessons how much I enjoyed teaching science and seeing the students so interested in science.

When I began talking to my mentor, Cathy Tubbs, and other teachers in our division about our third unit of study, Prehistoric Life, I was disheartened at the negativity all the teachers had towards it. When I heard the students were to be learning about dinosaurs and fossils I automatically thought this would be a great unit because I felt that first and second graders would be excited to learn about dinosaurs. After hearing how old the unit was and the lack of interesting lessons to go along with the unit, I thought this would be a great unit to make more inquiry based, which would be a great inquiry project. A few weeks before the start of the Prehistoric Life unit, we had our unit planning and I found out that we would be using an addendum to the unit, which was written by Judi Kur, Marcia Heitzmann, Corinne Almquist and Deb Shockey. This addendum, Mystery Dinosaurs, was written for teachers that wanted to add scientific inquiry to the unit. I was excited to find out that there was a way to teach dinosaurs using inquiry, however, I felt that I no longer had an inquiry project.

After talking to my supervisor, Kimber Mitchell, we decided that I could teach the Mystery Dinosaurs addendum and see how teaching an inquiry based science unit would increase my students' understanding of scientific reasoning and thinking. The rationale for the Mystery Dinosaurs addendum states,

> This addendum is intended to be used by teachers who would like to add scientific inquiry to the Prehistoric Life/Fossil unit. Dom Lesson stated in an article in the *New York Times* (1991) "Dinosaurs are often a child's first introduction to science. As such, they could be the key to engendering a life long interest in all science." It has been our

experience in teaching the unit that the learning our students did was reading about other people's discoveries, not making their own. We found that our students, like those mentioned by Craig Munsart in his book, *Investigating Science with Dinosaurs* (1993) "easily memorized names and dimensions of dinosaurs but learned little about the science that surrounds them." It was our intention to create an inquiry based focus for the unit. We wanted our students to use the scientific process to ask and answer questions.

Research Findings

I began to learn more about inquiry based science while enrolled in Science Education 458 in the fall of 2004. Our textbooks for the class were *Investigating Real Data in the Classroom: Expanding Children's Understanding of Math and Science* by Richard Lehrer and Leona Schauble and *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning* by Steve Olson and Susan Loucks-Horsley. Through reading these texts and articles from *Science and Children* and various other publications, I have learned more about teaching science through inquiry and questioning students to probe their understanding. The *National Science Education Standards* define inquiry in education as

> A multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations (Loucks-Horsley & Olson, 2000, p. 13).

Through my Science Education class and my research (Bass & Carin, 2001; Loucks-Horsley & Olson, 2000) I learned about the essential features of classroom inquiry or the 5-E Instructional Model. The first E in the model stands for engage; "learners are engaged by scientifically oriented questions….Scientists recognize two primary kinds of scientific questions. Existence questions…include many 'why' questions….There are also causal/functional questions, which…include most of the 'how' questions" (Loucks-Horsley & Olson, 2000). During this stage, the teacher would generate curiosity about the topic, raise questions, have the students make predictions and fill in the K, what they think they know, and W, what they want to know, on a KWL chart.

The second E in the model stands for explore. During this stage, the teacher "encourages students to work together…, observes and listens to students…, [and] asks probing questions to redirect the students' investigations." The student, while in the explore stage, "tests predictions and hypotheses, forms new predictions and hypotheses, tries alternatives…, [and] records observations and ideas" (Bass & Carin, 2001). The student would also use his/her senses to test things out and collect data and evidence through observations.

The third E in the model stands for explain. During this stage, the teacher "encourages students to explain concepts and definitions in their own words, asks for justification (evidence) and clarification from students, [and] uses students' previous experiences as the basis for explaining concepts." The student, during this stage, "explains possible solutions or answers to others, listens critically to one another's explanations, questions one another's explanations, [and] uses recorded observations in explanations" (Bass & Carin, 2001).

The fourth E in the model stands for elaborate. During this stage, the teacher "expects students to use…explanations provided previously, encourages students to apply or extend the

concepts and skills in new situations, reminds students of alternative explanations, [and] refers students to existing data and evidence and asks: 'What do you already know?' 'Why do you think…?'" The student, during this stage, applies concepts previously learned in similar situations, "uses previous information to ask questions, propose solutions, make decisions, [and] design experiments, draws reasonable conclusions from evidence, [and] records observations and explanations" (Bass & Carin, 2001).

The fifth, and last, E in the model stands for evaluate. During this stage, the teacher, "observes students as they apply new concepts and skills, assesses students' knowledge and/or skills, looks for evidence that students have changed their thinking or behaviors, allows students to assess their own learning and group-process skills, [and] asks open-ended questions, such as: 'Why do you think…?' 'What evidence do you have?' 'What do you know about x?' 'How would you explain x?'" The student, during this stage, "answers open-ended questions by using observations, evidence, and previously accepted explanations, demonstrates an understanding or knowledge of the concept or skill, [and] asks related questions that would encourage future investigations" (Bass & Carin, 2001).

Wonderings and Questions

My big wondering was, can teaching an inquiry based unit increase my students' understanding of scientific reasoning and thinking? Some of my sub wonderings and questions were:

What do my students already know about the scientific process?
How can I add more to the unit and make it inquiry based?
What questions do I need to ask?
Is it possible to teach during centers?
Is it possible to teach in homogeneous group instead of heterogeneous groups?
How much time do I need?

Are there adaptations I need to make to meet the science concepts and state standards?

What are the important steps in the inquiry process?

What are the steps in the discovery process?

My Inquiry Plan

What I Did to Carry Out My Inquiry

My inquiry started during our primary division unit planning for the Prehistoric Life/Fossils unit. During this planning, we were introduced to the Mystery Dinosaurs addendum and as a division decided to use it. The addendum is set up so a class can be split up into one or six paleontology teams. Each team is assigned a mystery dinosaur and throughout the unit they receive letters from one of six paleontologists. The paleontologists send clues in their letters about the mystery dinosaur and then they ask the students to respond to them in different ways. From the letters and clues, the students have to figure out their mystery dinosaur.

After our planning, I met with Kimber to discuss my inquiry project and we decided that I would teach the addendum. We made plans to meet with Judi Kur, one of the writers of the addendum, to go over the addendum and to discuss any questions or concerns I had.

Before I met with Judi Kur, I thoroughly read through the addendum and began to plan when I would teach each lesson, so I would be sure to have time for every lesson. I made a weekly schedule (see Appendix A) with the week number, the lesson name, the amount of time I thought it would take and if it was a whole class or center activity. This schedule allowed me to know what I needed to accomplish each week and where I would be going.

When I met with Judi Kur, she answered my questions about the lessons and some of the wonderings I had about the unit. She also gave me some advice for the unit, such as having dinosaur research books available to the students so they can research their mystery dinosaur

when they receive a clue from their paleontologist. Judi Kur was also kind enough to lend me her collection of dinosaur research books and some of the materials for one lesson.

After talking to my mentor, Judi Kur and the other primary division teachers at Panorama, I decided that for our classroom it would be the most beneficial to teach the science lessons during centers in the morning. This meant that our groups would be homogeneously grouped instead of the recommended heterogeneously grouped, and that we would have four groups in our class, so we would have four mystery dinosaurs.

My next step in this process was to select which four dinosaurs I wanted to use for our paleontology groups. On the list of dinosaurs that is provided in the addendum, there are two dinosaurs that are pointed out to be difficult because of their large size. I decided to use one of these dinosaurs for our highest group, because it would give them more of a challenge. I then chose one of the smallest dinosaurs for our lowest group, because I felt that less time should be spent trying to figure out its size and more time should be spent on their scientific reasoning. I then picked out two dinosaurs that were from different locations for our middle two groups. Also, while I was deciding which four dinosaurs to pick, I kept in mind the location of the dinosaur, what time period it was found in, whether it was bipedal or quadrupedal and whether it was a carnivore or herbivore. I did this so the four groups could have four very different dinosaurs and so the students could learn from each other.

Once I had the dinosaurs picked for each group, I began writing up lesson plans that included the questions I would ask my students to encourage them to think more and to explain their thinking. Some of the questions I seemed to ask a lot were “how do you know…” and “why do you think…” based out of research from Loucks-Horsley & Olson, 2000. Jon Elstgeest

states, “When asking questions to stimulate children’s reasoning, make sure they include ‘what do you think about’ or ‘why do you think’” (Harlen, 1985).

Ways I Collected and Analyzed Data

Before I began teaching, I conducted two pre-tests. The first pre-test I conducted was a worksheet from Ranger Rick’s Nature Scope called “Who’s a Dinosaur?” This is a worksheet with ten pictures of animals and their names. The directions instruct the students to put an X through the animals that were not dinosaurs and circle the animals that were dinosaurs. I conducted this pre-interview with the entire class to see what, if any, misconceptions our students had about what dinosaurs are. The results of the class can be found in Appendix B and the worksheets from six of my students can be found in Appendix C.

The second pre-test I conducted was a pre-interview with six students that I chose. I chose three boys and three girls, two of which were from the highest group, two from the lowest group and one from each of our two middle groups. One of the students I chose, from the lowest group, is an ESL student and I wanted to see how an inquiry based science unit would further this student’s understanding. In this pre-interview, I asked the students ten questions, relating to dinosaurs, fossils and scientists, three main ideas that the students must learn about during the Prehistoric Life/Fossil unit. The questions for this interview were:

What are dinosaurs?
When did dinosaurs live?
Where did dinosaurs live?
What are fossils?
Can we use fossils today? How?
Do fossils tell us anything? What?
How are fossils made?
Do you know any scientists that worked with dinosaurs or fossils?

Who are they?

What do they do?

I audio taped these interviews and took notes during the interviews. After conducting the interviews, I listened to the tape and wrote down, word for word, what each student said. The actual interviews, with the students' responses, can be found in Appendix D.

Another pre-assessment I did, during the first week of the unit, was an activity in which I had the students work by themselves to draw a picture of what they thought a scientist looked like and where the scientist would work. I did this activity to see what misconceptions, if any, the students had about scientists. The majority of the students had at least one object drawn that was stereotypical of a scientist: man, white lab coat, glasses, and working in a lab with potions. After the students were finished drawing their scientist, I had each one share their scientist and tell a little about where their scientist works. We then had a group discussion about scientists. The results of this pre-assessment can be found in Appendix E.

After I conducted my pre-test and pre-interview I was ready to begin teaching. The first lesson was a modified KWL chart. I had the students write what they thought they knew on a yellow dinosaur cut out and what they wanted to know on a green dinosaur cut out. (See Appendix F) The wonderings of my students helped me to know what the students were interested in and what they really wanted to learn. I wrote all of the students' questions on a piece of chart paper, and this was displayed in our classroom throughout the entire Prehistoric Life unit.

After conducting my pre-assessment activities and the KWL lesson, I was ready to move into the unit and begin the Mystery Dinosaurs addendum. As I stated earlier, I included questions that I wanted to ask in my lessons plans, and for most of the lessons I have notes or

video of what the students said or thought. These lesson plans and notes can be found in Appendix G, along with my schedule of lessons for the unit, found in Appendix A.

In order to analyze my teaching data, I went back to the videos of the lessons and reviewed them. While watching I listened for what questions I asked the students to probe their understanding. I also listened for student explanations using evidence from our lessons.

Another way I was able to analyze my data and my students' understanding was by reading over their paleontologist notebooks. Each student was given a notebook at the beginning of the unit, in which there were worksheets that they would need for activities. After students received a letter from their paleontologist, they had to respond to their question and then the letter went into their notebook. For most of the lessons, the students had to do some type of recording or simple journaling. Examples of letters from the paleontologists can be found in Appendix H.

Once a week I read over every student's notebook and I kept track of how he/she was doing in his/her notebook. On my recording sheet, I marked two stars if I thought the student did an excellent job using evidence to support what they wrote. I marked one star if the student followed directions and completed the page well. If the page was finished but the student did not follow directions, I marked a check. If the page was not finished, the student received a dash and if it was missing from the notebook, I marked a circle. This recording sheet helped me to keep track of who was finishing their work and who was not, and it let me see what the students did or did not understand.

After teaching the unit, I conducted post assessments in the same way as I conducted my pre-assessments. I gave the entire class the "Who's a Dinosaur?" worksheet again and I

compared the worksheet from the pre-assessment to the post assessment to see if their previous misconceptions were changed. The results of this post assessment can be found in Appendix I.

I also conducted post interviews with the same six students I interviewed before the unit began. Again, I taped these interviews while I took notes, and later I listened to the tapes and wrote down, word for word, what each student said. The post interview consisted of the same ten questions as the pre-interview, and served as a comparison to the pre-interview to see what the students had learned. (See Appendix J for results.)

What I Learned and Now Know

Claims and What I Think I Now Know

Claim 1: Hands on learning helps students to better understand concepts.

Many lessons that I created during this unit had opportunities for the children to use hands on learning, which strengthened their conceptual learning. One lesson that is a good example of this was the "Seeing Like the Dinosaurs" activity (See Appendix G). During this activity, students wore brown paper bags to simulate how dinosaurs see. One type of bag was cut with two eyeholes in the front to simulate a dinosaur with stereovision, and the other type of bag was cut with one hole on either side of the bag to simulate a dinosaur with monovision.

In a previous lesson that day, I introduced the idea of stereovision and monovision. We looked at pictures of animals to see their eye placement and determined what kind of vision they

had. After this introduction, the students did not fully understand the concepts of two different types of visions. They could not get past the fact that we have stereovision but that there are animals that use their eyes independently of each other. Later that day I explained to the students that we would be playing a game to demonstrate how animals with monovision and stereovision see, and how vision would affect what they would eat. As a class, we went over the purpose of the game, which was to collect as many cubes (food) as they could with the bag on their head. Half of the class was given a bag with stereovision and the other half was given a bag with monovision.

When we went outside the students quickly collected all of the cubes. I asked the students to share how many cubes they collected and then I had them trade bags so they could experience the other type of vision. After each student had a chance to collect cubes with both types of vision, we came together in a circle to discuss the activity. I asked the children again how many cubes they collected this time and with what type of vision they had the easier time collecting the cubes.

> After each student had a chance to experience both monovision and stereovision, I brought the students together to have a discussion about the activity. I had the students share how many Unifix cubes they gathered each time, and I was surprised at the number of students who gathered the same amount or more cubes with the monovision bag. This information caught me off guard, but it actually worked well for the discussion. (I expected the students to be able to gather a lot more with stereovision.) I then asked the students when was it easier to gather the cubes and they all agreed that it was much easier with stereovision. When I asked them why everyone replied it was easier to see because they did not have to keep turning their head.

> We then went into a predator versus prey conversation, and discussed which type of vision would be the best for each role. The students decided, after some discussion, that a predator would want stereovision because they could see easier and they would be able to chase their prey. They also thought a dinosaur with stereovision would be a carnivore because it would be a predator (Personal Journal, 2005).

The students applied this activity to dinosaurs by realizing that it would be most beneficial for predators to have stereovision because of how much easier it was for them to collect cubes with the stereovision bag versus the monovision bag. The students continued to use the terms stereovision and monovision in a way that demonstrated their understanding of this concept throughout the remainder of the unit.

A second lesson that is a good example of the students using hands on learning was the "Dinosaur Teeth" lesson (See Appendix G). My objectives for this lesson were that students would discover that different teeth serve different purposes and students will learn that you can predict what an animal eats by its teeth. In order for the students to do this, I supplied them each with a Twizzler and a carrot. First, I had the students take a bite of their carrot and I asked them to focus on what teeth they used to bite. Almost all of the students bit the carrot using their incisors, and they were able to explain how their incisors are shaped. After some discussion, I had the students take a bite of the carrot again, but this time focus on the teeth they used to chew the carrot. All of the students explained that they used their molars because they are "bigger and thicker than incisors," they are "shaped so you can grind up food" and they are "made for crushing."

Next, I had the students take a bite of their Twizzler and focus on the teeth they used to bite. All of the students used their canine teeth, unless their canine teeth were missing, to bite

into their Twizzler. When asked why they used their canine teeth the students had many good responses. "Canine teeth are sharpest so you can rip better."

They are "pointy to rip things."

They are "sharp, upside down triangles and good to rip food."

By using food, such as carrots and Twizzlers, the students were able to more fully understand their own teeth and why they are shaped the way they are. Once the students had an understanding of their own teeth, they could move on and apply their knowledge of their teeth to dinosaur teeth. The next part of this lesson was having the students look at pictures of dinosaur skulls and deciding whether the dinosaur was a carnivore or an herbivore, and then explaining how they knew what they dinosaur ate. The students' explanations of how they know what the dinosaur ate referred back to their understanding of their own teeth. For example, "Dinosaur C ate plants because it has flat teeth just like our molars." "Dinosaur D ate meat because the teeth are like our two canines. To rip the food." (See Appendix K for examples of student work.)

Claim 2: Questioning students as they investigate helps them to elaborate their thinking and scientific reasoning.

Throughout my lesson plans I included questions that I felt would help to elaborate my students thinking and scientific reasoning. (See Appendix G for lesson plans.) I also used questioning in my lessons to get the students to back up their findings with evidence. Using questions such as 'how do you know' and 'why do you think' helped the students to more fully explain their thinking which led them to be able to use evidence to back up their findings.

One lesson that involved a lot of questioning while the students investigated was the "Mystery Box" lesson. This is a lesson in which there are a few small boxes with two or three everyday items inside. The mystery part comes in when the boxes are taped shut and the students are not allowed to open them or know for sure what is in the boxes. The students are given the mystery boxes, empty boxes of the same size and objects that could possibly be in the mystery box. In order for the students to explain their thinking and their scientific reasoning, I continually had to ask them questions to probe their thinking. The questions I found myself asking the most while the students were investigating with the mystery boxes were, after watching the video, "What do you think…?" "How do you know…?" "Why do you think…?"

The following is a dialogue of my questioning one of our ESL students, who is in our lowest group.

Teacher: "I want you to listen to this box, shake it around, try to figure out what's in there. What does it sound like?"

Student : "Like a square."

T: "Do they [the mystery box and the box the student created] sound the same? Do they feel the same? Put them in your hands."

S: "I found out what it is, its something like this!! [student shows a die.]

T: "Why do you think it is something like that?"

S: "Because it sounds like…I tried it slow…"

T: "What do you hear?"

S: "Umm, something falling, and the corners are the same shape." [The student slowly moved the boxes back and forth to let me hear. She meant she could hear the die falling into the corners and the boxes sounded the same.]

T: "Do you think there is anything else in there [the box]."

S: "I don't know."

T: "Shake it [the mystery box] around. Do you think there is one thing or more than one thing?"

S: She shook the box. "Two."

T: "So what else do you think might be in there?"

S: She went for more objects and continued to compare the boxes.

The "Dinosaur Teeth" lesson, talked about in Claim 1, is another good example of how questioning students as they investigate helps them to elaborate their thinking and scientific reasoning. During this lesson, I asked the students questions such as "Focus on what teeth you are using…" "What teeth are you using to…?" "How are those teeth shaped?" "Why do you think they are shaped that way?" These questions helped to focus the students on what I needed them to be focused on. The students had to first figure out why their own teeth are shaped the

way they are and what teeth they use for certain food before they could apply that knowledge to dinosaurs teeth.

Claim 3: Giving students a purpose, such as a mystery or a problem engages them to use resources in the classroom.

After my students received their first clue about their mystery dinosaur, the size of its foot, I introduced a bin full of dinosaur research books. I learned from Judi Kur that these books would play an important role during the Mystery Dinosaurs addendum, but I would have never imagined how much of a role they would play. The minute I told the students that there were research books available for them to use to search for their dinosaur they literally got up and ran to the bin to start researching. From that day on, the students were constantly asking me if they could research their dinosaur.

In later weeks, I began to include extra time in my lesson plans specifically for the students to research their dinosaur. During these times, I was teaching mini lessons about how to do research without even realizing what I was doing. I taught mini lessons on the table of contents and the index and the children were excited to learn because it made their research easier. I also taught the students ways to pick out information that they already knew about their mystery dinosaur so they could hopefully learn more.

In order to help my students stay organized with their mystery dinosaur clues, I created a worksheet that they could use to record what they found out about their dinosaur and what their evidence for that information was (See Appendix L). This worksheet was the first page in their paleontologist notebook, and it was what the students constantly referred to when they did their research. An example of what may have been written on this page is:

What I Know	Evidence
Mystery dinosaur was a carnivore.	Dinosaur had sharp teeth to rip meat.

Once the students had a few clues, they began to have an easier time narrowing down the list of possible dinosaurs, and they began sharing with me their predictions about their mystery dinosaur. They would get really excited when they thought they may have found their dinosaur and then very disappointed when they found something about the dinosaur that did not fit their mystery dinosaur's clues. It was really important for me to then explain to them that they were doing a great job researching and acting like a scientist, and that they were using their evidence very well. The following is a group conversation that took place when two students thought they figured out that the Velociraptor was their mystery dinosaur.

Teacher: "Why do you think the Velociraptor is you dinosaur?"

Student: "Never mind."

T: "Why did you think it was?"

S: "Well, because it [their mystery dinosaur] had a really sharp claw and the Velociraptor does."

T: "Why can't it be your dinosaur?"

S: "Because its [the Velociraptor fossils were found] in China."

T: "Where was your dinosaur found?"

S: "Montana."

Student 2: "Because it's [Velociraptor] too small, it needs to be 9 feet 4 inches."

Group one, our highest reading group, actually figured out their dinosaur a few lessons before the end of the unit.

While at their seats, many students were researching their mystery dinosaur. One student in particular was really working hard to find her dinosaur. When I was done with all of my centers, she came up to me and told me she thought she had found her dinosaur. I asked her how she knew and she showed me that it was from the same time period and same location, it was quadrupedal, and the size was correct. It turns out she really did find her mystery dinosaur! We talked briefly about how we may find out more information that might not match, but she should remember this dinosaur (Personal Journal, 2005).

Every time she received another clue about her mystery dinosaur, she wrote it down in her notebook and did research to make sure the new information matched the dinosaur she thought it was.

Claim 4: Having students assume the role of a scientist helps them to understand scientific processes.

"Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. *National Science Education Standards*, p. 23. As pointed out in the *National Science Education Standards* (National Research Council, 1996), students who use inquiry to learn science engage in many of the same activities and thinking processes as scientists who are seeking to expand human knowledge of the natural world" (Loucks-Horsley & Olson, 2000, p. 1).

During the entire unit, the students took on the role of being a scientist by thinking like a scientist, researching and solving problems. More specifically, they took on the role of being a paleontologist in their own paleontology team. While in these teams, they received letters from "real" paleontologists working in different parts of the world. I tried to play up the letters for the students, by putting them in envelopes and addressing them to each student, so that they could really get into the role of being a paleontologist.

Also, during this unit we learned about all of the different kinds of scientists that worked with dinosaurs. This was one of my questions in the pre and post interviews, "Do you know any scientists that worked with dinosaurs?" In the pre-interview, none of the students could name any scientists. In the post interview, all but one of the students were able to name at least two

scientists that worked with dinosaurs (See Appendix J). The following are two of the student's answers to the question concerning scientists:

> **Student 1 (boy):** Easy! First, there's the worker, and say it with me, the person who does the work. And first…the workers come and find the fossils and they just predict that they're fossils…And the geologist comes and he says what age it is and then the draftsman comes and draws the stuff. After that the worker says "yeah, I predicted right" or something like that. The specialist gets it ready for the museum right after they take pictures which the photographer does, everybody knows what a photographer does…(Student Interview, 2005).
>
> **Student 2 (girl):** Paleontologist, a geologist tells age of rocks and fossils. A specialist gets stuff ready for the museum. A draftsman draws picture of the find. Worker is a person who does all the work. Photographer takes pictures of the find.

The student I feel that made the most progress through this inquiry based unit was one of the students I interviewed. This student is a female ESL student who is in Title I for reading. During her pre-interview, she was only able to answer three questions. She thought that dinosaurs were "strange animals." When asked 'when did dinosaurs live?' she responded, "I don't remember," and with a prompt of 'do they live now?' she responded, "no." To the question of 'where did dinosaurs live?' she responded, "where the fire is." When I asked her to explain what she meant by fire, she described a volcano. She was not able to answer the questions about fossils or scientists.

During my post interview with this student, she was able to answer every question. She could tell me that some dinosaurs were "meat eaters, plant eaters, carnivores, herbivores and omnivores." She could also tell me that dinosaurs lived "long ago" in the "Triassic, Jurassic and

Cretaceous periods." When asked about fossils she knew that they are "bones that lay in ground and old" and that they are made by "mud on top of each other." She could also name two of the scientists that worked with dinosaurs and what their jobs were. "The workers work and the specialist get bones ready for museum." Teaching this inquiry-based unit helped all of my students' understanding, but it was especially beneficial for an ESL student to take on the role of a scientist to understand scientific concepts more easily.

Conclusions and Future Directions

Implications for My Future Practice as a Teacher

This inquiry has helped me to realize that I really enjoy teaching science, and I especially like teaching science when inquiry can be used. Having the experience to teach an inquiry based science unit has helped me to begin to learn what questions I need to ask and what I need to do in order to teach a successful inquiry based science lesson or unit. While planning lessons currently for our new unit, I try to consider how I can add inquiry to the lesson or how questioning the students could benefit their learning.

After seeing all of the progress and growth my students made during the Prehistoric Life/Fossils unit, I cannot imagine teaching science any other way. I was amazed by how much my students learned and the way they could make claims about their mystery dinosaur and support those claims with evidence.

New Wonderings I Have Developed

I know that next year, in my own classroom, inquiry based science will be an important part of my classroom. Since I do not know where I will be teaching next year, I wonder how my future district will look upon inquiry based science and how I can meet the state standards for science and for inquiry. I also wonder, because I probably will not be teaching in a unit based

curriculum, what the science unit will look like and whether I can use inquiry based science or not. Another wondering I have is how is science taught when it is not a unit based curriculum and how inquiry can be incorporated while using a textbook.

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