

Is Your Water Safe?

**Using Inquiry-Based Instruction to Educate Young Learners about
Water Pollution**

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Abstract:

What happens when a class of students discovers a source of pollution in a class aquarium? Will inquiry-based instruction help them to understand water contamination? This inquiry project investigates how the wonderings of a class of 2nd grade students guided their scientific journey towards becoming experts about water pollution. Come join me to discover how inquiry-based instruction can turn elementary aged children into scientists!

Teaching Context

Welcome to Room 20, here at Grays Woods Elementary! I am a Professional Development School (PDS) intern working for a full school year within this second grade classroom. My classroom is one of three second grade classrooms. Overall, there are six first and second grade classrooms within Grays Woods Elementary. I work collaboratively with my mentor teacher, a paraprofessional, and twenty-four enthusiastic and bright students. My classroom is made up of twelve girls and twelve boys, ages seven to nine. The diversity of my learners includes; one learning support student, who receives instruction five days a week, four students who receive Title I reading support, and two students who attend speech therapy classes four days a week. With such a diverse group, delivering differentiated instruction is necessary.

To facilitate successful learning within my room, my classroom environment and culture is focused around my student's individual needs. The physical appearance of my classroom is one that promotes community within our room. The student's desks are arranged in clusters to encourage social interaction and student support. The perimeter of the room is made up of resources (computers, bookshelves, paper, manipulatives, etc) that the children are encouraged to use. Our classroom supports each student's needs, whether it is working with peers, or working independently. There is plenty of room so that each child's space is respected. My teaching philosophies connect to the physical plan of my classroom. My mentor and I share the same mentality that a student-centered classroom is the best learning environment for all students. We develop our lessons based around the ideas that our students should be responsible for their own learning and for making their own decisions about learning strategies. A student-centered approach encourages cooperation, collaboration, and respect. It is a method of learning that meets

the educational and emotional needs of each student within my classroom. Student-centered learning guides students into becoming independent thinkers by allowing them to take ownership of their learning.

Rationale

My Professional Development School experience has prepared me for teaching inquiry-based instruction. Until this past year, I had never heard of the word “inquiry.” My first hands-on experience with the topic was in my science methods course. During this class, my instructor prepared me well for teaching science on an elementary level through the use of inquiry. There is an old proverb that states, “Tell me and I forget, show me and I remember, involve me and I understand.” This saying is the basis for inquiry learning. By involving children in their own learning, they begin to develop new knowledge that becomes meaningful and applicable to them. The students are the ones who design their own learning so that it makes sense to them. They are also actively engaged during the process because it is something they have designed, which allows them to take ownership over the lesson. Teachers develop inquiry-based lessons based on wonderings or questions of their students about a specific subject matter. The teacher becomes responsible for asking the core questions of inquiry “how do you know that?” and “why do you know that?” These questions require the learner to provide evidence to support any claims that they have developed after the experiment is completed. During the lessons, the students are involved in important explorations that help to connect prior knowledge with the new concepts. Through the explorations, the students are able to

generate evidence that will help them during the explanation that comes at the end of all inquiry-based lessons.

My first experience with teaching inquiry came during our *Land of Make Believe* unit. I was given the opportunity to teach three science lessons on magnets. I was responsible for teaching the first two lessons, which really scared me. I was surprised to hear that my students already knew a lot about magnets, which also served as a challenge. I wondered how I was going to use inquiry to “re-teach” material some of them already knew. My first lesson focused on a mystery envelope filled with four objects. This experiment challenged the students to figure out what was in the envelope with only a paper clip and a magnet. During this activity I began to see light-bulbs turn on inside my student’s minds and they became excited. With my guidance, they were able to develop claims that they supported with concrete evidence from the experiment. After this first lesson, I was no longer afraid to use an inquiry-based approach to my teaching. The magnet lessons really helped me to develop a love for teaching science. Through my teaching, my student’s were able to develop claims such as “magnets repel other magnets on one side.” By the end of the *Land of Make Believe* unit, my children had become magnet experts. They were able to use magnet vocabulary, such as attract and repel, correctly in their science discussions and also able to write wonderful sentences about magnets.

Empowered by the results of this teaching experience, I knew I wanted to conduct an inquiry project focused on teaching science. Inquiry is a powerful teaching tool that opens many new doors that remain closed when information is just given to them. Teaching the magnet lessons helped me to understand the full potential of inquiry.

Inquiry-based lessons provide students with a higher level of thinking that allows them to become responsible for their own learning. While reading over the pilot unit entitled *Underwater Life* I quickly realized that second graders had never been taught about water pollution. I began to wonder about how using inquiry could help my class to better understand this complex topic.

What Others Think and Know About This Topic

After contacting a variety of experts and reading several articles about teaching inquiry to young learners, I became more informed on a professional point of view about using this teaching technique to teach science. I also conducted background research to gain better insight about how other teachers have approached creating science lessons about water pollution. I discovered that the *National Science Education Standards* (NSES) has created guidelines that all science instruction should follow within the classroom. They believe that science is a subject area that develops important skills that will be needed to make everyday choices. Children need to develop scientific literacy in order to develop essential skills, such as the ability to reason, think logically, make decisions, solve problems, and think creatively. "The intent of the *Standards* can be expressed in a single phrase: Science standards for all students," (NSES, 2002). Inquiry-based instruction can fulfill these needs. NSES defines scientific inquiry as, "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world." During science

instruction, children need the opportunities to interact with hands-on materials that will help support their learning of new knowledge. The National Science Teachers Association (NSTA) also embraces the use of scientific inquiry because it helps children to “interact with their environment, ask questions, and seek ways to answer those questions. Understanding science content is significantly enhanced when ideas are anchored to inquiry experiences,” (NSTA, October 2004).

According to NSES, one of the main purposes of science education is to give students a means to understand and act on personal and social issues (NSES, 2002). To achieve this goal, children need to be informed and involved with important issues so that they develop the skills necessary to discuss and act on these issues. Critical thinking and logical reasoning abilities are an essential part of these skills. The 5 E’s of inquiry (engage, explore, explain, elaborate, and evaluate) support these beliefs and can aid in the growth of these understandings within young children. “The 5 E’s allows students and teachers to experience common activities, to use and build on prior knowledge and experience, to construct meaning, and to continually assess their understanding of a concept” (Enhancing Education, 2002).

Researching about water pollution education for young learners was a little more challenging than finding information about scientific inquiry. According to Molly A. Hetrick, an expert from Millbrook Marsh Environmental Center, it is important to “get very visual with the kids when teaching about water pollution,” (Hetrick, 2006). She went on to explain that its extremely important to have an engaging introduction to pull the students in and then “give them an activity they can really put their hands on, which helps them to visualize what you are teaching,” (Hetrick, 2006). Structuring the lessons

is essential to the learning outcomes. According to Molly, this is how she plans her lessons for kids who come to the marsh:

- 1.) Introduction/discussions- what is water pollution, where does it come from, how does it affect us?
- 2.) Team Activity- give cards with examples/pictures/scenarios and kids decide in a group whether it is pollution or not.
- 3.) Hands-on Demonstration- Using our model of a wetland, we would add pollution to our wetland and talk about Point-Source and Non-Point Source pollution. Discussion- how does this affect us. Then go through a second time and talk about what we could do differently to prevent this (during this time kids manipulate the model and we discuss it as a group).
- 4.) Follow-up activities (Hetrick, 2006).

Wonderings/Questions

Pollution is a complex topic, but I was up to the challenge of creating lessons that were appropriate for my students so that they could gain a better understanding of this concept. However, I had several questions and wonderings prior to beginning this project.

- What knowledge do my students already have about pollution?
- What kinds of activities would be most helpful for teaching pollution conceptually?
- How can teaching about pollution help my students relate more to their environment?

- Will hands-on lessons increase my student's love for science?
- In an inquiry-based science lesson, will my students be able to generate connections among the material?
- In an inquiry-based science lesson, will my students be able to retain the information so that they can write about it?
- How can an inquiry-based unit on water pollution increase my student's excitement for science?
- **Inquiry question: How can inquiry-based science instruction help my students learn about water pollution?**

Inquiry vs. Project

The word inquiry is defined in the dictionary as “a close examination of a matter in a search for information or truth,” (www.thefreedictionary.com). It is a teaching tool that opens important doors for all learners. My question focuses on creating meaningful situations for my students that will guide them in developing important concepts about water pollution. I am not seeking to improve the science instruction within my own classroom, rather I want to present new material using a method that will engage and inspire my children. My wonderings focus on manipulating a complex topic, like water pollution, and place it on an attainable level for all the learners in my class. I do not wish to find a definite answer through this inquiry; I hope to broaden my own knowledge about using inquiry as a tool for making education as meaningful as possible.

Inquiry Plan

Implementing the Plan:

Organizing a series of lessons within a unit takes time and analysis. As I thought about how I wanted to introduce this lesson into my classroom, I immediately thought about the few aquariums that were having trouble surviving. About 4 weeks into our *Life under the Sea* unit I found myself contemplating and brainstorming ideas with my mentor. I quickly realized that this project was quickly coming to a start. I also thought about how this project was my own and these lessons were now my responsibility to teach

Step One: Collection of Prior Knowledge

To begin my project, I gathered prior knowledge from my students about what they already knew about water pollution. Prior knowledge is an important teaching tool that is essential to guiding the teaching within a unit or lesson. I used a technique discussed during an In-Service Day on differentiated instruction. During this lesson, I asked my students to talk with a partner about what they knew about water pollution in thirty seconds. It was the partner's job to listen and take notes, if needed, about what their peer was talking about. Once those thirty seconds were complete, it was now the other student's turn to talk for thirty seconds. The challenge was that the student could not repeat anything that was already said by their partner. During these discussions, I was able to make observations about which groups had trouble talking about this topics and which students had a plethora of knowledge surrounding this concept. Once this activity was complete, I took the time to have my students share their ideas, which allowed me to analyze their prior understandings of water pollution. These ideas were

then written down onto a fish-shaped piece of paper that would be added to a KLEW chart located at the side of the classroom (Appendix A).

A KLEW chart is a tool used to help organize student's thoughts and understandings throughout a lesson or unit. The K column of the chart represents what students already know about a topic. The L column is where they write about what they learned throughout an activity or entire unit. The L column is supported by the E column, which stands for evidence. A KLEW chart helps students learn to use evidence when making claims and they learn about the importance of having evidence when making scientific explanations. The last column, W, is a place for the student's wonderings. Through a lesson or unit it is extremely important to keep track of any questions that students may have. These questions can really help guide a lesson or unit and aid the teacher in developing activities that might center on some of these questions. KLEW charts align with the NSES standards that state, "which specifically emphasize the importance of engaging children in scientifically oriented questions, having students give priority to evidence and the development of evidence-based explanations, and justifying their proposed explanations," (NSES, 2002)

While I walked around and read what my student's were writing I realized that my students had a general understanding that water pollution was a "bad thing" and that it "killed animals and destroyed their homes." This really made me excited because I felt that through the use of inquiry-based instruction, my students would gain more specific understandings about the effects of water pollution.

Step 2: Lesson Planning

I took the time to organize all of the pollution lessons into an order that “made sense.” It is essential that lessons build on one another so that children begin to make important connections between the concepts and ideas. I placed the lessons in a sequential order, which allowed them to build on one another (Appendix B). I prepared six inquiry-based lessons. My mentor and I sat down each week in order to plan out a specific time that science would be taught each week. I made sure to develop a goal/learning objective for each activity in order to guide my analysis of the data throughout the project (Appendix C).

Methods of Data Collection:

A Pollution Journal I created for each of my students was the most crucial part of my data collection. The journal was a simple notebook that had an individualized label glued onto the front cover. I explained to my students that these journals would be used to write in various times throughout the unit. I also kept my own notepad as a means for jotting down quotes, writing about science discussions, and keeping track of my own observations. My own observations, kept through anecdotal records (Appendix D), also served a method for data collection. I would observe student behavior during the lessons, connections they were making among ideas, and their attitudes about science. The videos of some of the science lessons allowed me the opportunity to analyze science discussions, write down quotes I might have missed during the busy school day, and take a more detailed look at the ways in which my students were using evidence and explanation. I administered a student survey as my final method of data collection (Appendix E). This survey provided me with information about how my students felt about the pollution

lessons, what they learned during the lessons, and how it affected their enjoyment of science.

Analyzing Data

I first analyzed the samples of student writing from their Pollution Journals. I developed a rubric for each writing assignment that served as a guiding tool for assessing the understandings my students were or were not developing. I first read through each journal one by one prior to looking at the rubric to give me an idea of what my students were thinking about. I then went through a second time and used the rubric (Appendix F) to assess their writing. I was looking to see how my students were able to take ideas from the first three experiments and relate them to ways in which scientists can tell if water is polluted. The first writing assignment showed average results. Four out of my twenty-two students had excellent journal entries. The following entry is taken from Jessica's journal: "I think scientists check water for pollution by a higher concentration or a low concentration. High concentration means that the water is cloudy and that it has lots of pollution. And low concentration means that it is pretty clear and doesn't have lots of pollution." Her use of concentration in her writing demonstrated an understanding of the term and her ability to connect it to water pollution. Eight out of my class of twenty-two had average entries, and ten had below average results. A sample of each kind these works can be found in Appendix F. This first assignment showed me that most of my children were having trouble taking concepts and ideas learned during previous experiments and relate them to water pollution. They also needed a lot of guidance in using evidence while they were writing. The second piece of writing my students completed was a reflection piece that was completed almost three weeks after

that first writing assignment. I again used a rubric to analyze and assess their understandings (Appendix G). These results were much better than the first ones. Sixteen of my students scored an excellent on their piece of writing, which made me happy. Their writing showed me that my students were beginning to relate to their environment, understood the negative affects of pollution in a water environment, and they were really starting to understand the negative consequences water pollution can have on all living things, even ones that do not live in the water. One of the most powerful entries I read was by one of my students Dave:

“It makes me sad because a lot of the sea crechers where dieing from all the oil. It kills a lot of the animals and plants and that is bad for the environment. We read a book about the oil spill. There were otters that had oil on their fur. So some people took them and cleaned them up. They also tried to save the other animals. We can try to clean the oil by skimming it across the water,” (Appendix H).

The next piece of data I analyzed was my own notepad of observations and quotes that I collected throughout the project. Prior to the inquiry-based pollution lessons my students were extremely unenthusiastic about science. I over-heard several of my students saying things such as “Ugh! Not science again” or “Can’t we do something else.” My notepad has several quotes from my students that show the complete opposite. On March 16, two of my students approach me and said, “Miss Carrano I can’t wait for science, it’s my favorite subject. What we did yesterday was pretty awesome. My parents said we could do the experiment at home.” Although these do not show a connection to learning water pollution, it is a great illustration of how the use of inquiry helped make these experiments fun and meaningful to my students.

The next piece of data I analyzed was video footage from one of my harder lessons to teach that focused on substances that dissolve and do not dissolve in water. I used this footage as tool for analyzing my own teaching and to analyze what understandings my students were starting to develop. This lesson was the third experiment my class completed. While watching the discussion parts of the video I noticed several things. During my focus activity, which involved passing around a bottle of tap water and a bottle of water mixed with sand, my students immediately began using the word pollution while they were talking about what substance was in the one bottle. One of my students, Carrie, says, “I can tell which water is more polluted because that bottle (the one with the sand in it) is cloudier than the other.” This observation shows that her thinking patterns are beginning to focus on pollution almost immediately. She is attempting to relate sand to a type of water pollution. When I asked why my students think the sand is on the bottom, Carrie again tries to relate it to pollution. She says, “Maybe that’s how it makes it polluted and it goes down there because it can’t stay up in the water it has to float down to the bottom.” The video-taped discussion is concrete evidence that my students began to connect ideas together about pollution. Even before they begin conducting the experiments, they are creating connections between prior knowledge and new ideas about water pollution.

The last piece of data I analyzed was the student survey I gave to my students at the end my project. The questions from this survey are:

1. How much did you enjoy learning about pollution, on a scale from 1-4?
2. Which part of the pollution lessons did you like the most?
3. How much do you enjoy science, on a scale from 1-4?

4. Write 2 things you learned about water pollution below.

I used the information from this survey to make two different graphs (Appendix I). The first figure is a bar graph that compares the responses for question one with the responses to question three. I was curious to see if there was a correlation between the students who loved the pollution lessons and the students who love science. The second figure is a circle graph for the response to question two on the survey. I noticed some important trends in these graphs:

- The nine students who said they loved the pollution lessons were the same students who love science
- The nine people who said they liked the pollution lessons were the same students who like science
- 91.7% of my class enjoyed the experiments the most, compared to writing or just discussing pollution as a class
- Only one student out of twenty-four did not like the pollution lessons, but that student likes science

What I Learned and Now Know

Claim 1: The use of inquiry made my students proficient in using the scientific method.

Evidence: The use of inquiry helped my students learn to think more like scientists. They became experts with using the scientific method because the experiments we conducted forced them to use it in every lesson. By the end of four weeks, my students were able to use evidence with explanation when we held discussions. When I asked questions such as, “well how did you know?” or “why do you

think that is?” my children were able to use evidence they collected from their experiments to support their developing claims. Our KLEW chart at the end of my project is a great illustration of all the things my students learned and the evidence they used to support those findings (Appendix J). The NSES specifically stresses “the importance of engaging children in scientifically oriented questions, having students give priority to evidence and the development of evidence-based explanations, and justifying their proposed explanations,” (NSES 2002). The KLEW chart developed by my students gave them important practice in giving priority to evidence when delivering scientific claims. Another piece of evidence that took me by surprise happened once my project was completed. During parent-teacher conferences, the mother of one of my student’s voluntarily offered my mentor and me some interesting information. As we were wrapping up the conference, the mother started talking about her son’s involvement in the science fair. She discussed with us how motivated he was to be part of the fair. He is the youngest of four siblings and the mother told us that in the past she has had to sit down with his other brothers and sisters to spend time writing out the scientific method for their poster boards. She informed us that her son needed no help writing out his experiment because of the science experiments that were going on in our classroom. She said, “Matthew said he didn’t need any help because he had used the scientific method so many times before. He did his poster board all by himself and was able to know the difference between an observation and a conclusion.” This story helped me to understand the power of inquiry and its important connection with the scientific method.

Claim 2: Inquiry-based lessons about water pollution helped my students relate more to their environment.

Evidence: A series of hands-on experiments, the use of literature, and science talks helped to contribute to my student's feelings about pollution. Prior to these lessons, my students did not take the time to think about their environment and what effect they might have on it. The K column of our KLEW demonstrates their lack of understanding about water pollution. They were very uninterested at first, which I saw through my observations. They were looking around the room, talking to their neighbors, and not very talkative during our first discussion. Over the past five weeks, my students have grown to appreciate their environment and have a better understand how humans can negatively affect this world. In the picture below, one of my students voluntarily picked up Oliver and the Oil Spill and read it during her free time.



She wrote about it afterwards:

“I felt very sad for all the bald eagles because some of them went to heaven. The otters were living great when a tanker spilled oil. All of the clams were yucky and otters were sinking down to the bottom and they didn’t come back up...”

(Appendix K).

When I read this, I could not believe how emotional she got in her writing. I was amazed to see many of students showing interest in their environment and understanding how badly humans can hurt their environment. Another important observation that I noted did not have to do with a comment that was said or a sentence that was written about pollution. Rather, one of my students made his own shirt that said “No Pollution” on his sleeves written in puffy paint to wear during a musical performance about animals in the ocean. In the middle of his shirt, he drew a lake that had been contaminated with oil and other substances. When I asked him why he made the shirt he said, “Well, we are singing about living in the ocean and oil is a bad thing that can hurt the ocean and the animals in it.”

Claim 3: The use of strong inquiry-based instruction is a great tool for differentiating instruction through the use of diverse learning strategies, such as writing, hands-on experiments, and discussions to help aid in the development of understandings about water pollution for all students.

Evidence: Everyone learns in a different way. Some students are visual learners, yet others need to manipulate objects in order to make important connections, or are able to listen to a discussion and understand the new concept being taught. Inquiry is a teaching tool that provides the opportunity for teachers to use different types of teaching

strategies in order to educate children about new concepts. The student survey shows that 91.7% of my class liked the experiments the most. When I asked one of my students why he chose that as his answer he responded, “The experiments are fun but help us learn at the same time. The experiments helped me to see water pollution and how to clean it up.” It is very important as a teacher to address all types of learners so that they have the opportunity to be successful. The last question of my student survey asked my children to write two things they learned about water pollution. One of my students wrote, “I learned that polluted water can kill living things in the water. I also learned that polluted water is hard to clean up. I know that because I did an experiment.” Another one of my students wrote, “I learned that it is harmful to not just animals that live in places around there, it is also harmful to people.” These responses show that my students developed important understandings about pollution that connect to the experiments conducted throughout my project.

CONCLUSIONS

Implications for My Future Practice as a Teacher

In my future classroom I am definitely going to use inquiry-based instruction in the field of science. I feel that the use of inquiry guided my students in developing understandings about water pollution, and it also helped them learn to think more like scientists. They became very proficient in using the scientific method, their use of evidence with explanation increased, and their overall enjoyment for science increased. Inquiry is a great teaching tool that gets students involved in learning and gives them the opportunity to explore and discover new knowledge. I will consider the results of this project in the future when I begin to plan science for my students. The three claims I

developed based on this project will guide my instructional planning in my future classroom. My student-centered approach to inquiry has been successful during my pre-service teaching, and I will continue to create lessons in which students are actively engaged in their own learning.

Even though my I have completed this part of my inquiry I still have many wonderings:

- How can I guide my students in applying their knowledge about water pollution to other types of contaminates such as pesticides or fertilizers?
- How can an “EnviroScape” be used in an inquiry-based science unit to help promote new understandings about pollution?
- Is it possible to integrate social studies into an inquiry-based unit focusing on different types of pollution?
- Is it possible to incorporate hands-on experiments into every science topic in a curriculum? Is that more beneficial to young learners?

Unanswered questions are a wonderful guiding tool for future educators. I hope to apply some of these new wonderings to my own classroom so that I can further my professional development with the use of inquiry. Inquiry is an essential teaching tool that turns young learners into logical thinkers. It is a way of manipulating new wonderings into teachable and meaningful moments.

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