# Success in the Making: An Intern and Her Students' Journey Through an Inquiry Based Science Unit on Magnets

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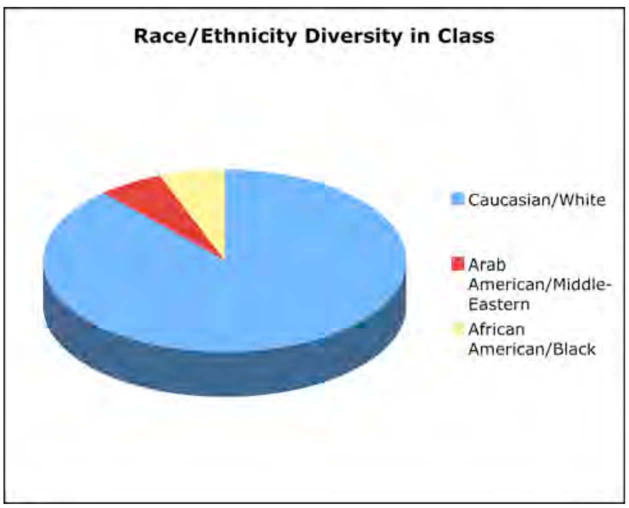
***Abstract:***

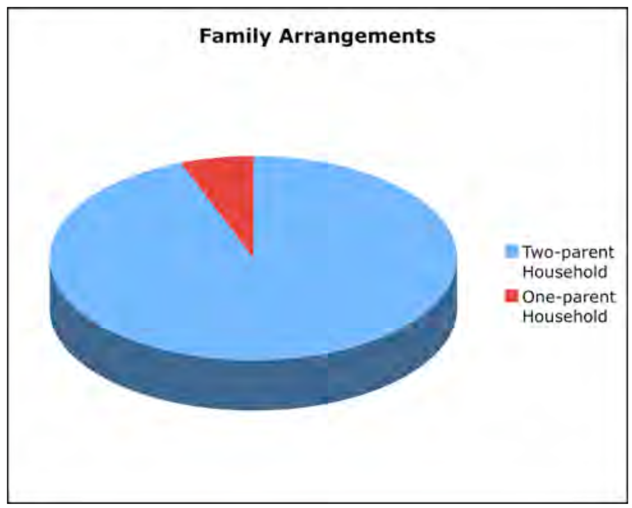
Teaching science through hands-on experiences is exciting. What happens, however, when you turn the control of the unit over to the students? This inquiry dives into one student teacher's experiences (and that of her students) as she leads and

facilitates a unit on magnets that is built around student wonderings, yet still needs to meet district outcomes and standards.

***Classroom Context:***

My first grade self-contained classroom is not especially diverse in terms of demographics. There are seventeen students: eight girls and nine boys. Aside from one African American boy and one girl whose family is from Jordan, the rest of the class is Caucasian. In terms of socio-economic status in my classroom the students range from what we might consider "lower-middle class" to "upper-middle class." With the exception of the one lower-middle class student who lives in a single parent household, all of my students live in two parent households. Twelve students' families are middle-middle class and four students' families are upper-middle class.




In terms of academics, in my class there are four students who are high achievers in mathematics. Eight students are achieving at or slightly above grade level expectations in math and four need significant teacher support and re-teaching. In terms of reading, five students are advanced readers and can read many books independently. Eight students are currently reading on a first grade level and making steady reading progress. However four students consistently struggle with basic sight word vocabulary and are just beginning to emerge as readers.

In terms of special needs, my classroom has one child who has autism and receives one on one support with a full time paraprofessional. Another student meets with the school counselor weekly for her exceptional emotional needs. We have one female student who is on IST and two (one female and one male) who receive speech therapy. There are five boys and one girl who have problems focusing and staying on task despite the fact that our curriculum encourages active learning. For example, students meet at four language arts centers each day and work in large groups, small groups, and individually throughout each day allowing students to focus for short periods of time. Socially, four boys and two girls stand out as clear leaders of the class yet two other boys and two other girls tend to be quiet and must be invited to join the group.

Corl Street Elementary School is a small school located in the midst of a suburban neighborhood. The school has approximately 275 students in kindergarten through fifth grade and has two classrooms per grade level. With only twelve classrooms, the school is a rather close-knit community – one of the smallest schools in the State College Area School District (SCASD).

***Background/Rationale:***

When I was an elementary student, each year my teachers primarily taught science with a textbook approach and we did few experiments. They forced us to memorize facts and assigned us endless chapters to read. In middle school, my science experiences became a little more hands-on and I was given some opportunities to experiment and make my own discoveries. It was not until college, when I enrolled in the Engineering 497 F, that I was able to understand how much fun science could be for children (or for me). This class really sparked my interest in becoming an effective science teacher. As part of our Professional Development School program, I began my fall semester methods courses in August of 2005. Taking these methods courses, especially Science Education 458 (Teaching Elementary School Science), has opened new doors to me for how I look at science and want to teach science to young children.

In the fall, my students were studying a unit called, *"Changes"*, which focused upon the different physical states of matter and changes between solids, liquids and gasses. While this unit involved daily experiments where students had to explain their learning with evidence, my mentor teacher did not elect to teach *"Changes"* through the process of inquiry. This stood out to me because inquiry based science was so central to my evolving teaching philosophy and was thoroughly championed in my science method course. *I began to wonder what the implications would be, for me as an educator, to successfully teach a unit to primary students through inquiry-based science.*

This wondering was important to me because, as a beginning teacher, I do not have much experience or knowledge in terms of teaching units of study to children. In order to become effective, particularly with science, I feel I need to learn to develop and implement units of inquiry-based science. Teaching science through an inquiry approach is important because students are given the opportunity to wonder and then encouraged to explore their wonderings. The idea is for the teacher to approach each lesson with a skeletal outline of what we might do, of course, but trust the students to redirect our learning activities based upon their wonderings and instincts to explore.

I decided to begin teaching the primary *Magnets* unit to my students through an inquiry-based approach. The first lesson of our unit began with a sorting activity and ended with me asking my students if they were interested in learning more about magnets

– the unit took off from there. For the next month, each science lesson I taught was representative of a complete inquiry approach.

My inquiry on teaching through inquiry-based science has profoundly affected my teaching and continues to inform my ever-evolving teaching philosophy and praxis. After teaching this unit on magnets, I have come to realize that I do not want to teach science in any other way without using the inquiry approach. Not only have my students benefited, but also I feel that I have also grown tremendously as a teacher. Together, my students and I have been able to work our way through the magnet unit and learn what the students set out to know.

***Literature:***

When talking about inquiry-based science, many different thoughts come to mind. For one thing, science as inquiry is a standard in the Pennsylvania State Science Standards. Located in Appendix A, you will see the standard 3.2. This standard states that students need to:

> Recognize and use the elements of scientific inquiry to solve problems.
>
> - Generate questions about objects, organisms and/or events that can be answered through scientific investigations.
> - Design an investigation.
> - Conduct an experiment.
> - State a conclusion that is consistent with the information. (Pennsylvania State Science Standards, 2005, p. 10-11).

As you can see, this standard relates perfectly with the principles of inquiry-based science.

In Teaching Science as Inquiry (2005), Carin, Bass and Contant state, " The central message that the National Science Education Standards convey is that students should be engaged in an inquiry approach to science that basically parallels the procedures scientists use and the attitudes they display in doing science" (p. 14). In other words, teaching through inquiry allows students the opportunity to consider a topic -- for my inquiry project the topic was *magnets* -- and with this topic come up with questions or wonderings to which they would like to find answers. These wonderings become the focal point for all of the science lessons and essentially serve to *create* the unit design.

> Through engaging in inquiry, students learn how scientific knowledge is generated; they learn how to investigate on their own and to work cooperatively with others and they construct meaningful knowledge that they can use in understanding the objects, organisms and events in their environment. (Carin, Bass & Contant, 2005, p. 14)

This quote relates directly to the learning going on in my classroom. My students have been able to work on their own and cooperatively to construct meaning about magnets.

According to the National Science Education Standards,

When children engage in inquiry they:

- Ask a question about objects, organisms and events in the environment.
- Plan and conduct a simple investigation.
- Use appropriate tools and techniques to gather and interpret data.
- Use evidence and scientific knowledge to develop explanations.
- Communicate investigations, data and explanations to others. (Carin, Bass & Contant, 2005, p. 21)

When looking back at my unit and comparing to the National Science Education Standards, I can say that my students were engaging in inquiry and each lesson was connected to the standards.

When beginning to think about teaching the unit on magnets through a completely inquiry-based approach, I contacted two primary teachers who work at another elementary school in SCASD: Marcia Heitzmann and Judi Kur. These two teachers were able to provide me with an article they wrote which focused on teaching magnets through inquiry-based science. The teachers found “that scientific inquiry helps students gain insights and increase their understanding of scientific principles,” (Heitzmann and Kur, 2005). After reading the article, one of the key pieces that stood out was, “How would it be possible for my students to come up with wonderings that are not only testable but also meet the district concepts?” Heitzmann and Kur (2005) stated, “that by restructuring our science lessons, using science talks and listening to our students, we were able to move their surprises and wonderings into testable questions and their questions were closely tied to what our district wanted us to teach.” I was able to directly relate to Heitzmann and Kur’s statements and found these same things happening in my classroom.

***Wonderings and Questions:***

After reviewing the literature, my primary wondering became clear***. “As a teacher, what are the implications for successfully teaching an inquiry-based unit on magnets to my first grade students?”*** Along with this main wondering, I also had several sub questions.

- Does teaching science through inquiry help me to meet all of the districts' standards/objectives as outlined in the unit?
- What may it entail for a unit, already incorporating hands-on activities to become an inquiry-based unit?
- What can I do as a teacher to encourage students to wonder and explore?

These wonderings have really allowed me to look at my inquiry as both a teacher-related inquiry *and* a student-related inquiry. It would be easy for me just to *say* I was successful teaching my students with an inquiry approach, but how would I truly know this without some sort of data and assessment? It became clear to me that in order to effectively be "successful" at teaching through an inquiry approach my students needed to "succeed" with it as well.

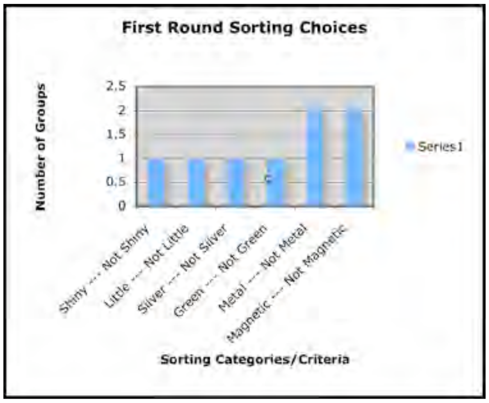
***Inquiry vs. Project***

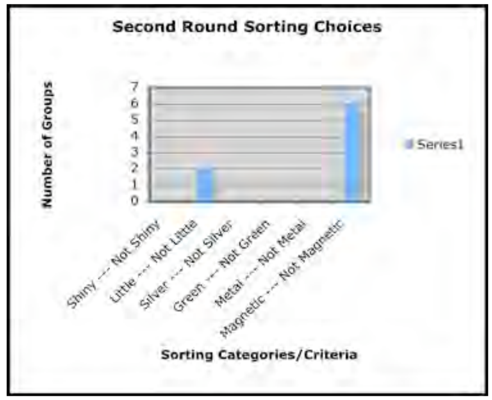
To me, my inquiry entails learning of new ways to conceive of the unit *and* discovering how to teach toward that end. How can I effectively teach my students through the inquiry process while successfully meeting the district guidelines? Through considerable trial and error I found my way to plan each of my lessons and introduce each day's experiment. I learned that there are many decisions and tasks teachers need to consider in order to effectively teach through inquiry. My wondering is definitely considered an inquiry because it allows for me to reflect and change my lessons. It also is an inquiry because my unit was geared for the students and for a new teacher. I wanted to not only be successful but I also wanted my students to be successful.

***Inquiry Plan Description:***

Prior to planning or teaching any of the actual *Magnet* unit, my mentor and I discussed some of the strategies other teachers have done to effectively incorporate inquiry into their classrooms. Once I had a basic understanding of what inquiry (or an inquiry project) entailed, I jumped in headfirst.

My goal for beginning the unit was to let the children feel as if they were choosing the topic of study. During my first lesson, I divided the students into groups and gave each group a bag of objects. Each bag consisted of one paper clip, crayon, piece of yarn, clip, coin, scissors, scrap of paper, pencil, plastic cube and a wand magnet. I gave my students the task of sorting the items in each group's bag into two groups and give each group a rule. Once each group had created a rule and sorted their objects accordingly, we all met on the carpet for a talk. The students were asked to share the different ways they decided to sort. There were many different rules presented, some included: big and little, green and not green, metal and not metal, and magnetic and not magnetic. My goal for the sorting was for at least one group to come up with the rule of magnetic and not magnetic and I was very pleased that two groups had already thought to sort their objects in this way. The students were then asked to sort again, this time using one of the ways their classmates just talked about. My goal for this part of the lesson was to see if the majority of the groups would go back to their seats and use the sorting rule of magnetic and not magnetic. Once again, they reached the goal: six out of the eight science groups sorted their objects into magnetic and not magnetic.




We again met on the carpet to discuss what rule we used to sort. Each group stated their rules and at the end I made a generalization to the class. I said, "I see a lot of groups sorted their objects by magnetic and not magnetic. It seems like you all have an interest in magnets, is this true?" The students all responded enthusiastically: "YES!!" Then I asked, "Would you like to study magnets as our next unit?" Again they replied with roaring yeses of excitement. Our *Magnets* unit had officially begun - *now all I had to do was keep the ball rolling!*

I began the second *Magnets* by revisiting the idea of a KLEW chart. My students were familiar with using a KLEW chart; however, it had been several months since they last used one and I wanted to make sure we all remembered how they work. The advantage of using a KLEW chart (documenting what students believe they **K**now, have **L**earned, have as **E**vidence, and **W**ant to know throughout the unit) as compares to a KWL chart (what they **K**now, **W**ant to know, and have **L**earned) is that KLEW helps "align with the National Science Education Standards, 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" (Hershberger, Zembal-Saul & Starr, 2005, p. 50). To model this idea, I planned to use that chart as one of the ways I would assess my students' learning; it would be a piece of *evidence* for my inquiry.

For our second day in the *Magnets* unit, I asked the students what they thought they knew about magnets already. I recorded their responses under the 'K' section of the chart. We then proceeded to write some questions and wonderings we had about magnets under the 'W' section of the chart. Throughout the *Magnets* unit, we would refer to these wonderings in each lesson.


Figure 1

I took this picture during the unit. As you can see, the "K" and the "W" section are completed. The "L" and the "E" section are located around the chart.

The third science lesson entailed some vital information that I needed to explain before the students would begin handling magnets in any form. Safety is a big issue in any classroom and magnets can indeed harm certain objects, so I wanted to ensure that our classroom computers and electronics would remain safe. In order to introduce magnet safety, I decided to use a *Sponge Bob Square Pants* episode that dealt with magnets. However, I "accidentally" left magnets on the VHS tape and when the students were watching the opening song, it somehow stopped working and went to fuzz. You can imagine how disappointed my first graders were to see the tape was ruined. This was a great opportunity for me to introduce the concept of magnets doing harm and ask students to help me in ensuring the safety of all equipment and belongings in our room.

After discussing what a magnet can harm, the fourth lesson addressed the question, “What does a magnet attract?” I developed this lesson from a list of students’ wonderings, so I focused on the students making predictions and drawing conclusions about what a magnet attracts. This lesson led directly into two new student wonderings: “Are all metals attracted by a magnet?” and “Can magnets attract through objects?” After discussing how magnets are able to attract one another through certain objects, the students posed questions dealing with magnet strength. The resultant magnet strength lessons I facilitated, gave the students an opportunity to design their own experiments. With this task, the students needed to come up with the question they wished to test, write down the predictions they made and collect data as they carried out their experiment.

After dedicating one full week to exploring magnet strength, the students were given a free day of exploration with the magnets. Several students initiated questions about *why* magnets attract each other on certain sides and not attract on others (sometimes even repelling one another). For the resultant lesson, I divided the students into two groups:  one group worked with my mentor teacher and the other worked with me. Here each group of students implemented a lesson of their own design. From this lesson, it was time to wrap up the unit. I moved on to my student’s final wondering.

The final question we tested in the *Magnets* unit dealt with the concept that the poles of the magnet are the strongest. I facilitated this lesson on the spur of the moment. When one student came up to me with his question, instead of just helping him find the answer, I brought the students back to the carpet and we worked to find the answer together.

Once the class had effectively answered all of the students' wonderings, I planned a culmination activity. The students took on the role of scientists and presented their findings about the learning they had done throughout the unit to a second grade class. The culmination went very smoothly.  My students were very excited to be presenting their learning and to also take on the scientist role.  Below is a picture of students presenting their magnet claim.

Throughout each lesson, I reflected upon what went well and what did not. I also documented the uneasiness I had before teaching certain lessons. I assessed my students throughout the unit by using science talks, journals and interviews. Once we had completed the *Magnets* unit, I sat down to consider and analyze my data in search of claims I thought I could make from this inquiry.

***Data Collection:***

I decided to use several methods for data collection: teacher reflections, student surveys, student work, photographs, assessment interviews and our class's KLEW chart for the *Magnets* unit.

- **Teacher Reflection**: I collected my data through two different types of teacher reflections. The first method I used was journals or written reflection. I wrote these journals both before and after lessons, reflecting on not only the teaching aspects but also what I would change if I could teach the lesson again. I also used audio to reflect on the extent of inquiry I was using as well as the purpose and function of my lessons. Appendix C shows the list of questions in which I used to reflect.
- **Student Surveys**: I incorporated student surveys to generate feedback about the way students were learning about magnets. It was important for me to get student feedback in order for me to plan future lessons. The survey was presented to the students in the middle of the unit.
- **Student Work**: I used student work (a.k.a "student journals," as we referred to them in my classroom) as a second method of collection. I used their journals as a record of what the students learned throughout each lesson. The journals were important because they allowed me to see what the students knew prior to an experiment and what they got as an end result (understood afterward). I did however have some problems with student journals. I found many of my students had trouble expressing what these thoughts were, especially in writing, and drawing conclusions from each experiment. When we were talking in a large group setting, my students were able to adequately convey what they had learned; I needed to take this distinction into consideration when it was time to begin analyzing my data.

- **Photographs**: Another method of data collection I opted to use was photography. I took pictures of the students throughout the science lessons to visually document the experiments as well as the conditions of each. By documenting the unit through photographs I was able to see evidence of how the students engaged with magnets throughout the unit.
- **Interview Assessment**: Student assessment was also a crucial way to collect data. In order to know if my teaching was successful, I needed to make sure the students had learned what they sought out to discover. I opted to use interview-based assessment because it allowed me to sit down and talk with the students one-on-one, which I believed would provide richer data than a written test or survey. This gave me a great understanding of what the students currently understood as well as if there were any misunderstandings.
- **KLEW Chart**: Another way of collecting data I used was the class's KLEW chart. The KLEW chart allowed me to see where the students *were* prior to the unit and then chart their learning throughout the unit. This has been an amazing source of data for me to see how much the students have learned throughout the unit.

***Data Analysis:***

After collecting my data, it was time to look for patterns, themes and key ideas to emerge, which would then lead me to make justifiable claims. In order to help me organize my data and find similarities I used several different strategies.

- **Teacher Reflection**: When analyzing my reflections, I used highlighting as a method. I re-read each journal and tried to find patterns in my experiences. See Appendix B for journal examples. For example, I looked for reflections that dealt with positive outcomes of each lesson as well as for reflections that addressed with my worries along the way. After breaking my reflections down, I was able to group my thoughts into key ideas. These were my key areas that emerged from my data: teacher success, teacher struggles, student success and excitement.

- **Student Surveys**: I also used a highlighting strategy to organize my student surveys, Where I looked to code my information with one of four questions: 1) What is your favorite part about studying magnets? 2) How do you feel about the way we are studying magnets (so far)? 3) If you could change anything about how we are studying magnets, what would you change? 4) Do you want to design more experiments by yourself? Of these questions, I highlighted each using a different color and then placed surveys into piles. Once I created the piles, I was able to generate claims from the surveys. Appendix F has a chart, which shows the similarities I found when reviewing student surveys. Overall, I found students enjoyed creating their own experiments and liked the way we were studying magnets. Appendix E has samples of student work and journals.
- **Student Work**: I tried to use student journals as an assessment tool; however, I found some problems with using this method as a format of assessment for this inquiry. Many of my students expressed signs of frustration with completing their science journals. Looking at the conclusions they were drawing (in writing) for each lesson, I found a great deal of variety in their answers. By coding their responses and grouping similar themes together to analyze, I have gained insight into their learning.

- **Photographs**: To analyze my photographs, I categorized and re-categorized the different pictures I collected by affective expression (of the students pictured) and experiment. I sorted the images by the experiment the children were working on and also the excitement in their faces. See Appendix D for photographs. I was pleased to look back and see how involved they were in testing and collecting data. It also was a great way to trigger my memory about each question and wondering.
- **Assessment Interview**: When I revisited my student interview assessments I did several things. First I organized the questions and responses. Once this was done, I was able to break each question down and categorize each response. By separating and categorizing, it made it easier to find similarities among my students. After analyzing my student's assessments, I was able to find that an overwhelming majority had learned not only the standards set forth by the district but also surpassed them. I assessed my students on the different types of a magnet, all seventeen successfully were able to name each magnet. Another assessment strategy I used was simply talking to the students during my science talks. I asked each student to state something they learned and then give evidence that supports it. My students were again doing well.
- **KLEW Chart**: Analyzing my KLEW chart was difficult. I began by looking at what my students thought they knew about magnets. I compared these to what they wondered about magnets. I noticed some pieces contradicted each other. An example of this is my students thought that when magnets are put together, they make a buzzing sound. I then proceeded to looking at what the students learned and the evidence they provided to support their learning. I compared these learning's

with what they thought they knew in the beginning. I noticed many students had a few misconceptions about magnets in the beginning, however when looking at the chart now, their misconceptions have been replaced by facts and evidence. Some misconceptions that have been replaced by facts is that magnet size does not equal magnet strength.  My students originally thought that the bigger the magnet the stronger it will be.  However, after experimenting, my students were able to see that this is not true.

- ***Claims****:*

After collecting data and using several strategies to analyze it, I feel justified in making the following claims.

- **Claim 1: Despite what may appear as though the students do all the work, teaching science using an inquiry approach is challenging for the teacher as well and can create a sense of dissonance for him or her**.

**Evidence**: Up until the second to last magnet lesson, I had gone through this inquiry-based science unit without much stress or worry. However, when it came to the concept of magnetic poles, I hit a roadblock. This is the lesson when it first hit me; teaching through inquiry is hard work. Looking at the journal entry I wrote just prior to teaching my lesson on magnetic poles I have found several underlying similarities.

> I feel so far, I have successfully taught my students about magnet strength, what a magnet attracts and if a magnet can attract through an object. Why was this concept of magnetic poles so difficult for me to tackle? (February 19, 2006 – Appendix B.1)

As I reflected upon and across multiple journal entries, I found several points to support this claim. One of the first challenges that presented itself during my unit study was how could I challenge my especially capable “high achiever” students in science?

> There are a few students in my classroom who already know the concepts the State College Area School District expects them to know by the *Magnets* unit’s end. It was difficult to determine *how* to challenge these students, when their classmates do not have this or comparable background knowledge. (February 12, 2006 – Appendix B.2)

After giving this some consideration and reflecting on the KLEW chart we created in class, I noticed there were a few problems with these students who *"knew everything."* There were many misconceptions in their thinking, which afforded me opportunities to approach each concept and introduce them to the students who were new to this information and to clarify or reinforce facts for my students with misconceptions.

Another challenge I was faced came in deciding *how* I should teach the subject, of magnets. One reflection provides evidence to support this claim.

> There is nothing I can base my teaching off of. I did not have the opportunity to talk with other colleagues in my building about this because only one other teacher in my division who is teaching through an inquiry approach went about teaching her students in a completely different way. (Journal – March 19, 2006)

After reading this support in a journal entry, I began reflecting back about what my struggles were in the beginning. I remember thinking, *How am I going to ensure my students are getting what they need to learn out of this unit? How am I going to introduce the driving questions we need to have without forcing them onto my students?* as I began to question where I began and where I finished. I realized teaching inquiry is not easy; it is extremely difficult and hard to predict.

- **Claim 2: Teaching science [paired with a culture of reflection] using an inquiry approach is rewarding to the teacher as well as the students.**

**Evidence:** Teacher reflection was very important for me because it gave me an outlet for my thoughts and feelings - to make sense of classroom struggles and successes. By using reflection I was able to consider changes I would make for future lessons as well as what

I felt went especially well. When looking back at my journals and audio reflections there were several trends I noticed.

One trend I noticed was that I was initially very optimistic and enthusiastic about my upcoming inquiry-based; as such, my earliest reflections were not about issues I was having or concerns about my teaching. Instead I had written about how much I was learning and how excited I was to be continuing. In my first weekly reflection I wrote,

> I feel my first week of science teaching went better than I had hoped. My students were very responsive to what we were discussing and also seemed very excited to be learning about magnets. My next few weeks will be devoted to teaching science through inquiry and allowing my students to help design the experiments we will be conducting. (Journal – February 5, 2006)

In my second reflection I wrote,

> "This lesson went really well. I felt the students were able to clearly see I expected of them. They also seemed really excited to begin working full time with the magnets." (Journal – February 12, 2006)

Both of these entries allowed me to reflect back on my rewards in the classroom during the inquiry unit.

By looking at my journal entries as the unit progressed, I saw new trends in my reflections. I began writing about "letting go" of my control as a teacher. Prior to this inquiry, I knew that to teach inquiry-based science, I would need to let go of some of my control as a teacher, however I assumed this applied more to *what* is taught (e.g. content) as opposed to how each lesson will go. During a lesson intended to address the question, *Do magnets attract through objects?* my goal was to have the students design their own experiment; I really wanted the students to be in charge. Later I wrote,

> I now enjoy having the students take control and really lead *me* in the direction *they* want to go. They have shown me how I, as a teacher, can just stop in the middle of a science talk or lesson, grab some materials and test questions they have right then and there." (Journal – February 19, 2006)

When I first started planning for the unit on magnets, I had a rough idea of how we would address their wonderings. Since the beginning, my rough sketch has completely gone out the window. I now do not feel as though it is entirely my responsibility to decide how I will introduce each new lesson. My students have naturally gone down a path where, after we tackle one wondering, someone brings up a new question about the lesson, which directly leads us into another wondering.

My students' excitement about learning also influenced my teaching and, in turn, made the experience especially rewarding. There were several weeks in which my students asked every day, *Miss Stevens, can we bring in magnets to use for our experiments? Can we have a day to just explore with our magnets?* By agreeing to grant these two student requests, I found I was able to not only appease my students but also discover new wonderings for the class to explore. Another helpful piece of evidence came from a boy in my class; he said, "I never liked coming to school before, but now that we have science and we are experimenting, I really like coming." Knowing that one of my students had become excited to come to school because of the *Magnets* unit I was teaching was truly rewarding. It made the unit (and my inquiry, for that matter) all worthwhile. My first grade students' excitement throughout the unit proved to me that if I relax some of my control and abdicate it to my students, they can rise to meet my expectations. Based upon the undeniable success of our *Magnets* unit, I cannot imagine teaching science without an inquiry approach. It just seems too powerful and rewarding to leave out of the pedagogical equation.

- **Claim 3: Primary students are capable of making decisions about their own science learning and they appreciate having the opportunity to learn in this way**.

**Evidence**: When looking at my students, I felt it was important to ask them how they wanted to learn about magnets in the upcoming lessons; after analyzing my surveys, here are the results. I found that the entire class (I surveyed sixteen students during the middle of the unit) liked the way we were currently studying magnets (with an inquiry based approach). Some of the more popular responses to that question were, *Yes, I like that we experiment*, *Yes, I like that I am experimenting to find out what metals stick*, and *Yes, because we get to study them*. Of the sixteen surveyed, nine responded to the question of *Do you want to design more experiments by yourself? Why or why not?* with the answer "Yes, because it is fun." Five students responded by just writing "no." One student answered the question, "no, because it is hard to design our own experiments" and one student wrote, "no, because I like to work with my partner." (This information is also located in Appendix F).

The second theme I found among their surveys was the students' favorite aspects of the *Magnets* unit was that "we got to experiment with them" and that they were able to find out "what magnets stick to and what they do not stick to." When using the word experiment, I am defining it as the students are creating and designing their own experiments. The students are using experiments to find out answers to their wonderings about *magnets*. There was also another common response found in their surveys. When asked *if you could change anything about how we are studying magnets, what would you do?* Ten students responded by saying they would wanted to do less writing. I took this feedback into account in my subsequent lessons by using less student journal pieces and more science talks. Previously students' journals had suffered due to the fact they were having a hard time effectively getting their ideas and understandings down on paper. If I asked them to describe what happened in the experiment, they could easily tell me in a face-to-face discussion, but when it came to putting it in writing, the majority of my class struggled. If I was teaching in an older grade, I feel my results would have been different and I would be able to expect more writing and conclusions.

My students also provided great evidence to support this claim by posing wonderings, which aligned perfectly with the district concepts and outcomes. There was never an instance where I had to *lead* the children into an experiment. Each experiment we completed produced a new wondering. Each new wondering led directly into a new experiment. The cycle just continued that way, developing a life and energy of its own.

- **Claim 4: Young children see themselves as scientists when they are actively involved imposing questions, gathering evidence and constructing explanations from their evidence**.

**Evidence**:


This picture shows my first grade students (in the white lab coats) presenting their findings on magnets to a group of second graders. I required the students to work in small groups and choose one claim about magnets (from what we had previously studied) to present for others. They needed to write their claim, have evidence present to support that claim and also demonstrate the experiment associated with that claim that we had completed earlier in class. The students were given the role of scientists, a role they did not take lightly. Appendix E is full of samples of my students' journals that support their learning and also provide great examples of them collecting data and looking for patterns and explanations. For each lesson, I asked the students to make a prediction, complete the experiment and at the same time collect their data. After they finished collecting data, I asked each student to write a conclusion about the day's learning.

This photograph shows students actively participating in an experiment to see whether or not magnets attract all metals. By simply laying out various metal objects, the students were able to test and record their data in regard to the objects they tested and draw the conclusion that not all metals are attracted to a magnet. Prior to this experiment, the students predicted that the majority of the objects would be attracted to the magnet. Most of my students were very surprised to discover that coins were not magnetic as some pencils were not magnetic. It was rewarding for my students (as well as for me) to experiment and discover these facts out themselves.

- **Claim 5: Teachers can lead students to meet standards while teaching science using an inquiry approach**.

**Evidence**: The State College Area School District has certain concepts and outcomes for primary students to learn during the *Magnets* unit. The following chart outlines the concepts the district requires its primary classroom teachers to address, shown side-by-side compared to the concepts my students learned.

| **State College Area School District Concepts and Outcomes** | **Concepts learned throughout our Magnet Unit** |
|---|---|
| 1. Magnets are useful to man | |
| 2. There are many types of magnets. All must be handled with care. | -Magnets harm some objects. |
| 3. Magnets attract some objects | -Magnets attract objects that are metal.<br>-Not all metals stick to magnets. |
| 4. Magnets attract objects through many materials. | Magnets attract through some objects. |
| 5. All magnets have a north and south pole. | -The magnetic poles are the strongest. |
| 6. Like poles of magnets repel each other. Unlike poles attract each other. | -Magnets attract and repel. |
| 7. The north pole of the magnet points to | -This topic was not discussed. |

| | |
|---|---|
| the magnetic north of the earth. | |
| | -All magnets to not have the same strength.<br>-Magnets names do not equal magnet strength.<br>-Size does not matter when talking about magnet strength |

As you can see, all of the district outcomes were not only met but also exceeded.  There was one concept that was not met, but after discussing this topic with the Curriculum support teacher, I was told not to worry about it.

***Conclusion/Future Wonderings:***

Teaching Magnets through the inquiry-based science approach has not only opened my eyes to a new approach to teaching science but also a way I will continue using.  My upcoming science unit of study deals with Underwater Life.  With this unit, I once again am going to be using the inquiry approach.  However there are some questions I have when starting this next unit.

- How can I teach through the inquiry approach when other teachers do not believe in this practice?
- What can be done to facilitate a unit, which does not lend itself to use inquiry-based science?

**Reference:**


Carin, A., Bass, J., and Contant, T. (2005). *Teaching Science as Inquiry*. Upper Saddle River, New Jersey: Pearson Prentice Hall.

Heitzmann, M. and Kur, J. (2006). *Magnets: Attracting Student Wonderings.*

Hershberger, K., Zembal-Saul, C., and Starr, Mary. (2006). *Evidence Helps the KWL Get a KLEW*. Science and Children, 50-53.

Pennsylvania State Science Standards (2005). 10-11.

## Appendix A: Standards

### 3.2. Inquiry and Design

***Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to . . .***

**GRADE 4**

A. Identify and use the nature of scientific and technological knowledge.
- Distinguish between a scientific fact and a belief.
- Provide clear explanations that account for observations and results.
- Relate how new information can change existing perceptions.

B. Describe objects in the world using the five senses.
- Recognize observational descriptors from each of the five senses (e.g., see-blue, feel-rough).
- Use observations to develop a descriptive vocabulary.

C. Recognize and use the elements of scientific inquiry to solve problems.
- Generate questions about objects, organisms and/or events that can be answered through scientific investigations.
- Design an investigation.
- Conduct an experiment.
- State a conclusion that is consistent with the information.

D. Recognize and use the technological design process to solve problems.
- Recognize and explain basic problems.
- Identify possible solutions and their course of action.
- Try a solution.
- Describe the solution, identify its impacts and modify if necessary.
- Show the steps taken and the results.

## Appendix B: Journals

**B.1**

Megan Stevens
CI 495
Reflection Journal
February 19, 2006

This week again was full of science teaching and learning both by my students and myself. We dove into the wondering, “Do Magnets Attract Through an Object?” I let go of the normal teaching routine and lesson and just went in with a few ideas for the first day. My goal was to have the students design the experiment. I wanted them to be in charge. This really challenged me as planner when designing my plan. Normally, most lesson plans are very detailed and drawn up exactly how the lesson is designed to go. In this case, I have realized that I was not going to be able to do this. Yes, I wrote down a somewhat plan of how I wanted to begin and where I wanted the students at the end, but I was not able to be very specific during my actual written lesson plan.

Though, typically I am not that type of teacher who likes to just go in with an idea and run with it, however through this science teaching using the inquiry method. I have grown very accustomed to it. I now enjoy having the students take control and really lead me in the direction they want to go. They have shown me how I as a teacher can just stop in the middle of a science talk, grab some materials, and test questions they have right then and there. This type of science teaching has allowed me to see, through a hands-on experience, teaching does not have to follow a plan. Things come up and change the way you thought you were going. When I first started planning for this unit on Magnets. I had a rough idea of the way we would go through their wonderings. Since beginning, my rough sketch has completely gone out the window. I now do not have to worry about how can I introduce this next lesson, my students have just naturally gone down a path where after one wondering is tackled, someone brings up question about the day's lesson which leads us directly into another week of experimentation.

I also have been incorporating the KLEW chart into my teaching on inquiry-based science. Based on previous teaching of science, my students had somewhat of a tough time explaining their learning using evidence. With the use of the KLEW chart every week and requiring my students to use evidence to prove why, for example, not all metals are attracted to magnets, they are better able to explain their thinking. Still there are times, where as a teacher of first graders, my questions need to be probing and I occasionally need to really take the time to get things out of them. However, I feel they have adapted to this type of science learning and are excited to explain why they think the way they do.

As saying before, this week's science lessons were designed to allow the students to take charge of the learning. They designed the experiment and brainstormed what we needed to carry out the experiment. I felt the students really enjoyed coming up with these ideas because the experiment gave them ownership. Within the next week or two, I am going to conduct a survey of the students to see what way they enjoy learning science. Halfway through the unit, I would like to hear their opinion on whether or not they like designing the way they will learn or if they would rather be given an experiment and an outcome. I hope this will show me what I need to do or not do when teaching the remainder of the magnet unit. The main goal of mine, as a teacher, is to allow the students to go through the unit and learn what they want to learn.

So far, I feel the unit is going really well, sometimes I can't believe how well it is going. This week, the students will be experimenting with magnet strength and trying to answer three wonderings they have. These three wonderings were taken directly from the previous science talk about do magnets attract through objects. I was amazed that I did not even have to do any real probing and these questions were naturally brought up. This upcoming week I am going to once again, have the children help design a lesson dealing with magnet strength and then on the second day, carry out the experiment.

**B.2**

Megan Stevens
Reflective Journal
CI 495
February 12, 2006

This past week I taught two science lessons. Both science lessons were geared around the question, What does a Magnet Attract?. By using this "wondering" my students had, I was able to develop a set of lessons geared to something the students wanted to learn about.

The first of two science lessons this week let the children predict and experiment with the question, what does a magnet attract. Objects of all sorts were given to the students and they were asked to determine what were attracted to a magnet and what were not. When the students finished this, they then had to write a conclusion about their results. The answer I was looking for was a pattern that the objects attracted were all metals. This exact conclusion led us directly into the next lesson.

This lesson went really well. I felt the students were able to clearly see what was somewhat expected by me. They also seemed really excited to begin working full time with the magnets. Many of the students wrote conclusions that really showed me how much they know about magnets. I think for a little while, I have been under estimating them and their knowledge. There are a few students in my class that already have the knowledge State College wants them to know by the end of the unit. I am facing some difficulties in determining how I am to challenge these students when the majority of the class does not have the knowledge.

Currently I have been using lessons designed for the class, but expecting a conclusion that really hits the ball out of the park. With these expectations, I have really been keeping the students who I can expect a lot of on their toes. I feel by expecting a lot from them, I will be able to help them further their understanding of magnets.

On the second day of teaching about what magnets attract we focused on a question posed from the end of the first day. The students were wondering if all metals would stick to magnets. I felt this was a great wondering where I could include student opinions on how we would test for results. The students discussed testing a variety of metal objects and record our results. With this said, I brought in a multitude of objects and set them on the back table. The students were given a journal sheet and given free reign of what objects they would like to test.

I really felt like I let go of a lot of power during this lesson and let the children take control. I was very impressed with their behavior and results. After going through our testing, we met on the back carpet for a science talk. We discussed our results and filled out our L and E of our KLEW chart. Their evidence supporting the learning claim were more in depth than I thought they would be. I also found that I had to ask certain questions to get the answers I needed. In some ways I manipulated my questions to gain evidence I needed. The students also impressed me in this area because of the results they gave to me.  My first graders have begun to see what I am going to expect from them.  They are becoming learners who question and learners who can explain their thinking.  I am excited to continue to working towards my approach of inquiry and am still learning each and every day.

# Appendix C: Tessa Reflection

## Weekly Reflection Questions

To what extent did the science lessons you taught this week reflect teaching science as inquiry? Use a rating scale from 1-5, with 5 representing the highest level of science as inquiry. Explain your answer.

What science concepts did you intend for students to learn this week? Why is it important for students to know this?
Provide an overview of your lessons.

What knowledge of students' thinking/ideas influenced your teaching?

In what ways did your enacted lessons differ from what you planned? Explain what influenced these changes/differences.

Were there other factors that influenced your teaching?

Identify what you believe were the best examples of the following and explain why:

Children collecting data/observations

Students looking for patterns in data/observations

Students constructing explanations from evidence

Students discussing/debating evidence and/or explanations

What kinds of things did you need to do as a teacher to support explanation development and science talk?

How effective were your science lessons at supporting student learning? Provide evidence to support your answer.

How will what you learned from teaching science this week influence what you do in the next few lessons?