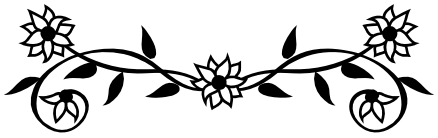
From Seed to Seed

Looking at the results of inquiry-based lessons and new resources in a second grade classroom



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Background

With our Pioneer unit fast approaching, I, as unit chair, began to wonder what science unit would be the best fit to compliment this social studies unit. In the past,

primary children have always studied the seasons with pioneers, but for several reasons, it was not the best fit. First of all, the new kindergarten curriculum is heavily saturated with season activities. Through the changing seasons, all students learn many concepts first hand through their own life experiences. Using an inquiry approach to seasons lacked potential and true substance. In my opinion, teaching this science unit would be redundant and inappropriate for primary students.

With doubts about the curriculum regarding seasons, I talked to my division, as well as, our curriculum support teacher about teaching plants instead. In the past, other schools in the district had paired these two units up. After all, pioneers packed seeds and transplants as they traveled west, which was highlighted in much of the literature utilized in the unit. After settling in a new home, the pioneer families would need to plant garden then tend it to ensure survival. Soil type and climate would determine when planting would occur, as well as, what crops would be grown and harvested. The two units appeared to be a natural fit to my division.

In the past, we have always taught plant concepts with the unit The Wonderful World of Nature. Often, I felt the unit got shortchanged because we had so much to cover involving animals and pest management. Even though we had taught plants the previous fall, we all agreed to teach the plant curriculum this spring.

With the decision made, I now needed to think about how I was going to address the various plant objectives and standards in a meaningful way to my classroom of second grade students. The plant unit itself was incredibly outdated and not widely utilized. First of all, I wanted to create a more inquiry-based unit. After all, teaching inquiry is one of the national standards. The National Education Standards (2004) state that children from grades kindergarten to fourth should be able to:

1. Ask a question about objects, organisms, and events in the environment.
2. Plan and conduct a simple investigation.
3. Employ simple equipment and tools to gather data and extend the senses.
4. Use data to construct a reasonable explanation.
5. Communicate investigations and explanations.

I felt confident that I could effectively teach the various plant concepts using this inquiry based protocol.

Secondly, I wanted to consider utilizing a new resource suggested by Eve Evans, the district's curriculum support teacher. When my division decided to focus our attention on the plant unit, she introduced the idea of including Wisconsin Fast Plants, which have never been used in any of the elementary schools in the district before. These genetically engineered plants would complete a life cycle from seed to seed in roughly six weeks, providing the children with wonderful opportunities to monitor plant growth. I was curious to gage how effective this resource would be in promoting student understanding.

Thinking about this inquiry project, I found myself with one main overarching wondering. What understandings about the life cycle of plants will students develop from using an inquiry-based unit? I also found myself with several related sub-wonderings.

1. What misconceptions about plant life do the students have?
2. What specific types of understandings will result from using inquiry based lessons?

3. What specific types of wonderings will result from the use of resources such as fast growing plants?

More wonderings developed as a result of a differentiating instruction activity that I completed with my primary division, principal, and curriculum support teachers at unit planning. In the ladder activity, we looked at levels of student understanding, which can guide instruction. We believed:

1. All students can identify a plant, observe and draw, and know seeds are related to plants.
2. Many students know a plant is a living thing, are able to sequence their observations in a clear order, as well as, describe and ask questions about their observations.
3. Few students know what a seed needs to grow or germinate, know other ways to grow plants (transplants, bulbs, cuttings), know how to design an experiment to test wonderings, and explain the life cycle from seed to plant.
4. No one understands pollination or the interdependence of living things, can explain the life cycle from seed to seed, and describe alternate ways of growing things like hydroponics.

The ladder discussion focused on how learning needed to be differentiated to meet student needs. In our meeting, we talked about whether or not students could truly understand concepts such as pollination or the complete life cycle of a plant. These sub-wonderings were a direct result of the ladder discussion:

1. Will the students understand the life cycle of a plant from seed to seed?
2. Can they grasp the concept of cross pollination?
3. Will they develop a better understanding of the interdependence of living things?

My Inquiry Plan

Now that I had developed my wonderings, I needed to create a plan that would not only address my questions, but most importantly provide quality education to my students. The framework for my plan was simple and straight forward. First, I would

conduct pre-assessments to tap student prior knowledge. Based on my findings, I would design inquiry based lessons regarding plant life. During this time period, a new resource, Wisconsin Fast Plants, would be utilized. After the completion of the unit, I would assess student learning by comparing it to the pre-assessment data. Throughout this entire time frame, locating and utilizing research would be essential. With this skeletal framework, I needed to add the specifics of how to make this unit on plant life meaningful to children, as well as, a venue for conducting inquiry.

Pre-assessments

Illustrations

Before I could begin teaching the unit to my students, I first needed to find out what they already knew about plants. Because my main wondering involved the students understanding the plant life cycle, I decided this was the area to focus my pre-assessment on. After reading an article by Schussler and Winslow (2007) entitled Drawing on Students' Knowledge in Science and Children, I mirrored my assessment on what was proposed in the write up.

The students would be asked to illustrate the life cycle of a plant beginning with a seed. Because we had previously observed a monarch caterpillar develop a chrysalis then emerge as a butterfly, I tied the concept of a life cycle to this past experience. In a whole group discussion, the children learned that one type of plant we were going to grow was Wisconsin Fast Plants. I then simply showed them one of the seeds in order for them to begin their drawings.

After getting their paper and sitting down to work, they all quickly began to draw. There weren't a lot of questions about the assignment at all. As I circulated around the room, I noticed how different the drawings were. Some drawings were rather simple, whereas, others were quite elaborate. Some students only had four stages in their life cycle. Others had as many as ten. A handful of students illustrations were extremely clear, whereas, others were would require questioning as to what was happening in the pictures. Overall, I felt this pre-assessment would provide me with critical information to begin the unit.

As Schussler and Winslow (2007) proposed, I began looking for various plant features, as well as, three plant concepts, pollination, plant dying, and seed dispersal, which could be present. Overall in examining the pre-assessments as a whole, I notice how primitive their drawings looked in general. Each flower had a round circle for the center with five or more petals around it. Each stem had two plant leaves attached. Out of my seventeen students, all started their life cycles with a seed, but only sixteen included a flower and only fourteen included leaves. Other features I was looking for were lacking in their illustrations. Roots and flower buds could be located in only about half of the cycles, whereas, seedlings, seed leaves, and seedpods were not found in any.

Looking for signs of scientific processes, I was wondering if any of my students would include various concepts that pertain to plant life. I wondered if a child would draw a bee resting on a flower for pollination, but none did. Looking for signs of seed dispersal, I found only one excellent example in which the student drew the life cycle of a

dandelion with the seed blowing away at the end. At the end of the life cycle, a plant dies. Two students included this concept in their pre-assessments. Overall, I found a wide range of knowledge represented in the illustrations, but all were lacking various components of plant growth and development.

After I analyzed the pre-assessments (appendix 1) and conducted more research, I learned that drawing could be a valuable tool to facilitate children develop and document more complex understandings of science (Stein, McNair, and Butcher, 2001). Their drawings provided me with key information of their prior knowledge, but I began to wonder how their illustrations could become a constant in the plant unit to further enhance their observational skills.

Interviews

After the life cycle illustrations were complete, I found myself with a lot of questions about what select students had drawn, so I decided to conduct interviews. Originally, I was planning on having the illustrations stand alone as my sole source of data, but was concerned I could be misinterpreting what I saw. I wanted to be sure I understood what my students' prior knowledge truly was before beginning the unit for two reasons. First of all, their knowledge or lack of would guide instruction. Secondly, I wanted to make sure I had accurate data to support this inquiry project. I felt sure that the interviews would provide me with a better framework of understanding to work with. To accomplish these interviews, I planned on speaking with ten students using their illustrations for a springboard to discussion.

Prior to sitting down with individual students, I developed a list of relevant vocabulary I would be looking for in regards to the plant life cycle. I thought as I asked them about their illustrations I could circle key vocabulary words used, as well as, take notes about our dialogue. I was looking forward to this opportunity to conduct one on one interviews.

To begin each interview, I simply asked the student to explain his or her life cycle picture to me. What was happening in the illustration? As I listened to each child, I understood most illustrations represented what the students did indeed know.

Stephanie had six squares drawn on her paper. The first four represented the seed alone growing larger in each box. In the next two boxes, she simply drew a flower growing in the same manner as the seed. I felt sure she could elaborate on her life cycle but she simply drew what she knew. She told me, "The seed grows bigger and bigger and bigger and bigger then it is a flower. The flower grows bigger and bigger and bigger." In this instance, the child drew what she understood about the plant life cycle.

In another interview, I discovered I was reading too much into the illustration. Looking at Stephen's final step in his life cycle, I saw a seed dropping out of the flower which meant he saw the cycle from seed to seed, although there were gaps in his understanding. This meant he also tied seed dispersal into his picture. As we sat down to talk, he didn't mention the seed which I saw so clearly in his work. When I directed his attention to it, he explained that the dot was not a seed but a period he intended to place after the numeral five. After all, this was the fifth step in his life cycle. This particular interview provided me with data that clarified his illustration.

Lessons

Now that I had a collection of data about what my students knew about plants, I proceeded to plan my science instruction. As I had stated before, the plant unit was incredibly outdated in terms of teaching ideas. Inquiry was not the overarching way to teach science to elementary children when the unit was created. I really needed to design and implement an inquiry based unit on plants based on the district objectives and state standards.

In the past several years, I had myself grown in teaching using an inquiry model for other science topics such as magnets, fossils, and animals. Some of the content we are required to cover is difficult to teach using an inquiry approach but I was quite sure plants would be a perfect fit for this venue.

Before starting the unit, I was slightly concerned that students that attended Easterly Parkway last year would say, "We have done this before!" because they may have. The prior year, they had completed the unit entitled the Wonderful World of Nature, which focused on plants and animals. I knew from the pre-assessments that regardless of their past experiences they had many gaps in their understanding of plant life. Curriculum spirals. This was an opportunity for the children to build on the past experiences from the previous year's experiences. Not once did a child propose the idea that we were being redundant this second year in teaching plants.

To begin the unit logically, we began learning about seeds. My first lesson required the students to take seed out of various types of fruits and vegetables. In doing so, they compared and contrast different types of seeds and where they came from.

The first seed activity became a springboard for utilizing the KLEW chart, which is a tool that gages student understanding, provides opportunities for scientific reasoning, and drives future activities through student generated wonderings about the content being taught. I was impressed with what the students had learned from this one activity. Not only did they learn from this experience, they were able to support their claims with supporting evidence from this experience.

For instance, one particular claim was that there are many different types of seeds. The students were able to support this claim with three pieces of evidence.

1. Seeds come out of different fruits and vegetables, such as avocados, green peppers, and apples.
2. Seeds can be different colors. Avocado seeds are brown, green bean seeds are green, and pepper seeds are white.
3. Some seeds are big like the avocado and coconut, but some are small like the apple and pepper seeds.

Wonderings from this same activity guided future instruction allowing the children to have a voice in planning and designing upcoming activities.

As we continued our seed journey, the class had the opportunity to open up lima beans, discovering what actually was inside a seed. The students in teams created experiments to test what seeds needed to grow into a plant or germinate, then presented the findings to their classmates. Throughout these investigations, the KLEW chart was used to promote an inquiry way of sharing what was learned.

After the class had multiple opportunities to study seeds, we moved into plants as a new resource was tapped. Wisconsin Fast Plants had great potential for providing the students with inquiry based plant experiences in a relatively short span of time. I was

optimistic but also concerned. I knew this venue could be an incredible opportunity for the children to observe first hand the entire plant life cycle from seed to seed, but what would happen if these plants failed to provide what they promised or neglected to impact student understanding. In the past, I had minimal success with growing plants from seeds in the classroom. Would these fast plants be any different?

In order to grow the seeds, I needed one other new resource, a greenhouse, to provide the plants with constant light twenty four hours a day, seven days a week. I also want to consult with my curriculum support teacher, Eve Evans who originally shared this idea with me. Initially, she provided me with key resources to utilize. From using the text she shared with me, I learned key information relevant to the growth and development of fast plants. Background information such as a planting and growing calendar was essential for proper implementation. We scheduled regular opportunities for Eve to come into my classroom during science to gage the effectiveness of the program.

Immediately after our spring break, we planted the seeds, hoping to see them emerge in a timely manner. They were scheduled to pop out of the soil and need to be thinned within a five day time period. To my surprise, the fast plants did exactly that. Never before had I observed healthy plants grow at such a quick rate. One student commented, "These plants should be called really, really fast plants instead of fast plants." It was true. The plants were fulfilling their promise of growing as predicted, allowing the children to observe plant growth first hand, as well as, motivating the children to be constant observers.

After we thinned our plants, a new KLEW chart developed as the framework for whole group science talks about plants. Based on their observations, children could state what they had learned and support these claims with evidence. For example, one claim made was the seeds grew into plants. The children had three pieces of evidence to support this claim.

1. With a magnifying glass, we could see the plant growing out of a seed.
2. We found empty seed coats.
3. There are now plants in the quads where we planted the seeds.

If evidence was lacking, we designed other experiments to learn more about a given idea. For instance, one child claimed that the soil contained nutrients for the plants to grow. His evidence was the plants we had thinned that looked the healthiest had clumps of soil clinging to their roots. Those that were not as healthy looking didn't have as much soil in the root system. To test this notion out further, we planted pansies in three different types of dirt - soil, sandy soil, and sand. The results of this experiment provided the class with more evidence to support the claim that good soil does benefit plant growth.

Based on their observations, the students also added relevant wonderings to the KLEW chart. In the past, wonderings varied in which few were testable, others required research, and still others were too vague or abstract to actually find an answer. The answers to the majority of wonderings raised by experiences with fast plants were found in more quality observations of the plants themselves.

1. How fast will the plants grow?
2. How big will the plant grow?
3. What will it grow into?

4. Will the plants grow more leaves?

For those wonderings that were testable, experiments were designed. One particular wondering that emerged that was used to design an experiment was questioning what plants need to live.

In order to guide observations, journals were used. Students recorded relevant data such as the plant's age and size, as well as, wonderings then illustrated to the best of their abilities what they saw. I was impressed with their illustrations which were quite realistic. The children noticed the details, as well as, compared and contrasted what they were observing. The class added to their journals roughly once a week, but it really depended on what was occurring with the plants. If the plants went through a growth spurt, they added. If buds formed, they added. Sometimes, a child would notice something I hadn't so we would pull out the journals to take note. After every entry, the KLEW chart was revisited with a science talk to share information.

Ongoing, I had hoped to address all of the state standards and district objectives that were relevant to this unit. In the class, we moved from one stage in plant development then onto another. Eventually, it was time for the flowers to be pollinated. This addressed the state standard regarding the interdependence of living things. I knew this was a topic not all children may understand, but hoped they would all understand the relationship between plants and bees on some level.

After we had read part of the book Honeybees by Joyce Milton, we discussed how bees need flowers, as well as, flowers need bees. Students, for the most part, appeared to understand that bees carry pollen from flower to flower which in turn makes more seeds. The evidence that they looked for was pollen on the dried bees we used to fly from flower to flower, as well as, finding seeds at the end of the life cycle. We did find both examples of evidence, but student understanding appeared to vary which was more evident in their journal writings. I would look for more in the post-assessments.

Overall, I felt confident that inquiry based lessons, as well as, Wisconsin Fast Plants had effectively impacted student understanding, but now I needed to conduct post-assessments to discover to what extent learning had occurred.

Post-Assessments

As I had done before the unit had begun, I asked the students to draw the life cycle of a plant beginning with a seed. I was excited to see what they learned from this experience. In examining the post assessments, the illustrations were more scientific. Each child with the exception of one in my class drew what they had observed specifically with the Wisconsin Fast Plants. The flowers, leaves, and other parts of the plant looked realistic. At first glance, I was impressed with how the students' illustrations had matured.

I was eager to sit down and tally the results regarding what plant features and concepts were included in their work. In examining the drawings, I found 88% of all students depicted many of the key attributes of the plants in the correct sequential order. Only a small percentage included plant concepts such as pollination, seed dispersal, and the plant dying. Pollination in particular proved to be a more difficult concept for second grade students to truly understand.

My next step would be to compare the pre and post-assessments, looking for data to support my claims.

Research

In looking for research to support my inquiry project, I predominantly looked for related articles in Science and Children, which was suggested by Carla Zembal-Saul. I searched for articles related to plants, inquiry, observation, and science talks.

Several books were recommended as well. Inquiry Science: Taking the Plunge by Wynne Harlen focused on the entire inquiry process. Even though in the past I had taught inquiry based lessons, I had never really read anything about it. Because I was interested in what the experts were saying about inquiry, this book was the perfect match for me. I also found Inquiry and the National Science Education Standards: A Guide for Teaching and Learning by the National Research Council. I looked for data about how inquiry was woven into the standards I needed to address.

In regards to Wisconsin Fast Plants, I was only able to find several resources. One article from Science and Children gave me ideas for conducting my pre-assessment. Some of the other materials I found were published by the same company that sells the seeds. Plant Growth and Development and The Seed Challenge were both published by the Carolina Biological Supply Company. Originally, I had hoped to find some more outside sources about these plants but was unsuccessful.

I also planned on meeting with Eve Evans, our curriculum support teacher, on a regular basis in order to discuss the effectiveness of the Wisconsin Fast Plants. Not only we discuss the program's successes, Eve would also spend time in my classroom, observing the effectiveness of the lessons.

Overall, I felt I had enough research to begin my journey. Now I would face the task of pulling it all together in one coherent project.

What I Learned and Now Know

After the completion of my inquiry plan, I examined all of my data and research in order to make claims.

Claim 1

Students harbor misconceptions about plants that can be drawn out through group discussions.

Sitting in a circle on the rug for a science talk, the children were always eager to share something they knew or had just learned about plants. During these conversations, it became evident to me that second grade children do have various misconceptions about plants. According to an article entitled Students' Ideas about Plants by Barman, Stein, Barman, and McNair (2003), research shows students' understanding about plants and what they need to grow is often limited. Understanding why they harbor misconceptions or nonscientific thoughts may hold the key to resolving them.

During one science talk about seeds, one student happily blurted out, "There's a flower in a seed." "Really," I said, "Could you tell me more?" "I just know a flower is inside," she said. At this time, I thought back to the activity we had previously completed which involved soaking lima beans, then dissecting them to find out exacting what a seed consisted of, which is a tiny plant or embryo, food storage, and seed coat. Yet even after we discussed this idea again and again, the notion of a flower being actually inside the seed popped up in class discussion.

I could see how a young child could believe this. The seed that was recently planted eventually would produce a flower, so in some analytical way, there really is the promise of a flower inside the seed. According to Wynne Harlen (2001), children develop ideas about the world based on casual observations, non-investigated events and hearsay which then become nonscientific notions. The longer they are held, the harder they are to change. The idea of a flower being inside a seed was one idea that was difficult to change, which became evident as it resurfaced again and again over a period of two weeks.

Eventually, another child piped up when once again someone explained that there was a flower in the seed. Explaining to the class that the flower actually would come later, but is not in the seed, she had started to piece together her observations. The entire class had observed plants growing and producing flowers in the classroom. Flowers, she observed, came after the seed leaves, plant leaves, and buds. After we discussed this notion, the idea of a flower being inside the seed never came up again.

During many science talks, the students would share prior knowledge they had about plants, some of which they brought from experiences or conversations had at home. During one conversation, one child said, "My mom told me you could plant flowers outside in winter." When I asked if the child or group could tell me more about this, other hands popped up. Another child agreed with the same notion. I began to wonder how much experience my class had with plants at home, so I prepared a survey to simply discover if they ever planted a seed, plant, or helped take care of them. The results were that roughly half of the class has planted seeds and plants at home, as well as, had a garden in their yard. The majority of students had house plants.

With these results from my survey, I reflected back what I had read in Wynne Harlen's book Taking the Plunge (2001). Maybe the students, even if they had experiences with plants, were simply making casual observations and creating their own ideas for what was occurring in nature. Possibly with scientific dialogue present even in everyday occurrences at home, children will formulate more meaningful and accurate knowledge about the world around them.

During a small group discussion about our fast growing plants, students were sharing predictions as to what might happen next as they grow. One child eagerly shared, "Maybe, they will grow into trees. Most plants grow into trees if they have enough rain, sun, and soil." Now, this comment was a surprise to me for several reasons. First of all, it was becoming obvious that the plants were near the end of their life cycle, as their petals had fallen off and leaves were turning brown. Secondly, this particular child was often leading the class in class discussions about plants. He appeared to have grasped all of the prior concepts presented, so this came out of left field.

As the other children in the group pondered this notion, I saw how effectively they could dispel this concept for this particular student. One child shared, "The seed tells you what the plant will grow into." Another stated, "If you plant an apple seed, an apple tree will grow, but if you plant a lima bean, a lima bean plant will grow." As the students talked, I could see they were changing his way of thinking. Eventually, he said, "I understand it now!" By providing students with the opportunity to have conversations, peers can be instrumental in changing misconceptions as well.

To help the children better understand the concept of pollination, I read a book entitled Honeybees by Joyce Milton. Our follow up conversation focused on how bees need flowers for nectar and pollen, but in turn, plants need bees to spread pollen from plant to plant to help make more seeds. In teaching second graders, I had only hoped that they would see an interdependent relationship. I had talked to my team about truly teaching the concept of pollination in a more detailed, scientific manner, but that would require talking about reproduction which I wasn't comfortable with. Neither was my team.

Later after we had pollinated our fast growing flowers using bee sticks, one group was talking about how bees and flowers need each other. One bright child said, "When bees pollinate flowers, they make space for the seeds to come out." Now, this surprised me, because we had not talked about this idea at all. This child did understand everything I had taught them about pollination, which was evident in his journal writing. In fact, he was one of the few students who included bees in his post-assessment illustration. It became apparent that he was creating his own ideas about pollination as if thinking that there just had to be more to it. Pollination is one aspect of the plant unit that I will revisit again before teaching the concept to future students.

Overall throughout the remainder of our unit, I discovered that my students were able to dispel some of their misconceptions by simply learning more about plants. In some ways, I think they were connecting their past knowledge or experiences with what they were observing and learning about now in the present in trying to make sense of it all. The notion of a flower being hidden away in a seed is the perfect example of how misconceptions can be changed. The change occurred after students were able to observe exactly how flowers do grow then participate in relevant scientific conversation about it.

From this experience, I find it essential to tap some of these misconceptions in order to change student beliefs, which can be more difficult to do as long as they believe them to be fact. Hopefully, from this unit, students will walk away with a wider base of scientific knowledge regarding plant life.

Claim 2

Wisconsin Fast Plants are an excellent resource for teaching various plant concepts.

Throughout the implementation of this unit, Wisconsin Fast Plants have proven to be an excellent resource to utilize to teach the plant life cycle, the parts of a plant, as well as, other concepts. Not only is it a reliable and teacher friendly resource, these plants were instrumental in teaching key plant concepts to second grade students.

First of all, everything went according to plan! In the past when my students planted seeds and placed them on the windowsill, we were fortunate to have our seeds germinate into a little plant with seed leaves over the course of a few weeks. Sometimes, because of room temperature, lack of water over a long week-end, or minimal sun, very little happened in our pots, but within five days, the fast plants required thinning.

Over the course of 44 days, the children were able to observe our plants grow. As one student put it, it was like the "circle of life." Very excited in a small group discussion, he said, "We planted seeds, little plants popped up, then we thinned, then we saw seed leaves, then plant leaves, then buds, then flowers, then we pollinated, and saw seed pods." Truly, they were able to see the entire life cycle of a plant within a few short weeks.

Evidence to support this particular claim was visible in a general comparison of the pre and post-assessments. As I sat and laid them out over the table, I was startled by the degree of improvement I noticed. Side by side, these illustrations looked incredibly different. The pre-assessments appeared to be very primitive compared to the more realistic and scientific post-assessments.

In searching for plant features and processes in the drawings, I discovered how much the students did learn from this experience. In all assessments, all students did include the seed as the starting point of their cycles, but that was part of the directions. Some changes were subtle. For instance, all seventeen students did include plant leaves, whereas, before fourteen had drawn leaves. Ironically, fifteen now drew flowers, but prior sixteen had. Some results doubled. For example, before eight had included roots, now sixteen drew them. Originally, six students had illustrated flower buds, now sixteen did. Other characteristics of plants were lacking totally in the pre-assessment. Now, six students illustrated seedlings, sixteen drew seed leaves and fifteen included seedpods in the post assessment.

In terms of plant processes, I originally had some doubts as to whether the children would truly understand pollination. Even though we were able to add the idea that bees pollinate flowers to make seeds to our KLEW chart with the supporting evidence of pollen found on the bees and seed pods growing on the plants, I wasn't sure all truly understood this concept. With the ladder activity, I hoped all children would

move up a step or two, but possibly not to very top where pollination was present. In the pre-assessment, no one included bees in their illustrations, but in their second drawing of the life cycle, five did. Some of the children did appear to understand this complex concept on a basic level. Processes such as seed dispersal and the plant dying showed no change. I feel this is due to the fact that simply the plants haven't died yet. In the next few weeks, I will revisit this topic to note any changes in student response after the plants have come to the end of their life cycle.

Overall with this data (appendix 5), I firmly feel the students now have a greater understanding of the parts of a plant, as well as, its life cycle due to Wisconsin Fast Plants. Out of the nine characteristics I was looking for, seven showed significant growth. My next step was to compare each individual child's work.

To better gage student level of understanding and growth for each individual student, I compared each child's pre and post-assessment of the life cycle. As I examined student work, I was startled by the growth in student understanding evident in the illustrations. Every child learned more about the life cycle of a plant, although some learned more than others.

In looking at Stephanie's work (appendixes 2 and 6), the degree of improvement was startling. In her original drawing, she simply has the seed growing bigger, bigger and bigger, then suddenly a flower appears with just a stem and roots. The flower, just like the seed, grows bigger, ending this particular plant life cycle. Stephanie only includes a seed, stem with roots, and flower. Her post-assessment includes all parts of the plant with the exception of seed leaves. In this illustration, the seed is planted grows roots, a stem with leaves, then a bud, which then flowers and ends with a seed pod. From this comparison, I can clearly gage her new level of understanding of plant life.

Eli's assessments (appendixes 3 and 7) were quite different than Stephanie's. In looking at his pre-assessment, he already knew several of the characteristics of plant grow and development. Starting with a seed, he went through the life cycle up to a flower. The key missing characteristics were the seedling, roots, seed leaves, and seed pods. In his post-assessment, he went from seed to seed pod, including seed leaves, roots, and seed pods, which were the missing elements he lacked before. I was also pleased to see Eli add one process to his illustration this time. A bee was hovering over his flower, representing pollination, which he noted with text. This was one student who did grasp this new concept, as well as, grew in his understanding of plant life.

One final student, I would like to comment on is Mohammed (appendixes 4 and 8). His pre-assessment had many key characteristics represented such as the seed, roots, plant leaves, flower bud, and flower, but they were all represented in isolation. Not only was his work more scientific in nature, Mohammed's post assessment clearly went from seed to seed with all plant stages evident, with the exception of a seedling. Mohammed drew a life cycle that was detailed and rich, depicting all he had learned from this fast plant experience.

Overall, a great amount of evidence was present to make this particular claim. Students did have a better understanding of plant life due to this resource. I would strongly recommend Wisconsin Fast Plants to any colleague interested in using it.

Claim 3

Through observation in inquiry science, second grade students can develop and support claims, as well as, generate relevant wonderings.

As I planned the plant unit, I knew I was going to utilize Wisconsin Fast Plants. Originally, I struggled with how I was going to make this an inquiry-based resource. After all, everything was laid out for the teacher with step-by-step directions on implementation. Because we had never planted fast plants before, I was hesitant to experiment with the process for fear of having plants die, not having enough flowers to pollinate, or not producing any seed pods, which would be the key to students seeing and understanding the complete life cycle of a plant. The students would be responsible for planting, thinning, pollinating flowers, and harvesting seeds. Throughout this process of growing the fast seeds, children would have opportunities for observation. Was observation enough? As I researched this topic, I discovered that observation is an essential element in teaching science.

Not only is observation the cornerstone of the inquiry process, it begins an investigation and continues throughout it. (Anderson, Martin, and Faszewski, 2006) During the entire period of time in which students were watching the fast plants grow and change, they were generated claims, collecting evidence, and developing wonderings as a result of observation. The children, as scientists, were looking carefully at what they noticed happening in attending to detail, noting change, and comparing the plants. The KLEW chart proven to be full of important information in documenting student thought processes through observation.

One claim that the class was able to support with data through their observations of Wisconsin Fast Plants was that the plants are growing and changing. Due to the nature of these plants, the children could observe plant growth at a much quicker rate than the typical plant. Gathered weekly to support this one claim, evidence was plentiful.

1. Pointy (plant) leaves are now growing.
2. The plants are getting bigger. We are measuring them.
3. Plants are growing buds.
4. Plants are growing flowers.
5. The pistils are growing out of the flowers.
6. Petals are falling off of the flowers.
7. The pistils are seed pods.

Another claim that was not ongoing but relevant to the particular growth spurt of the plants was the pistil is the seedpod. Evidence was also developed by students to support this claim.

1. The pistils are bumpy.
2. The pistils are getting fatter and longer.
3. We opened one up and found green seeds.

Wonderings developed from observing the fast plants proven to be relevant and thoughtful. Many of them could be answered by observing future changes in the growth of the plants.

1. How tall will the plants be?
2. Will the pistil fall off after the petals?

3. Will the seeds turn brown?
4. Will the seeds fall out?
5. How long will the plants live?

With the quality of student responses on our KLEW chart, I knew that through observation students were learning and understanding concepts related to plant growth via inquiry. According to Harlen (2001), observation is a skill used at all stages of inquiry: stimulus for raising questions, in linking past experiences to the present, in gathering information (measurements), in finding patterns and relationships between events and objects. Observation was the effective driving force behind inquiry science evident in our KLEW chart regarding fast plants.

Conclusions and Future Wonderings

With this inquiry experience coming to a close, I reflect back on all that was accomplished over the past few months. Not only were inquiry based lessons effective in

promoting student understanding of plant concepts, this experience provided me with a learning opportunity. I grew into a more thoughtful and analytical teacher of science. This change can be attributed to many different factors, such as all of the research I completed in my classroom, as well as, from outside experts and to the systematic way in which I began to approach science. Due to the nature of this project, I did spend a vast amount of time teaching and talking science with children and colleagues alike. Science was definitely in the air!

I began to wonder how other inquiry projects could have a similar impact on who I am as an educator. Throughout this process, I felt recharged and empowered. I thought about the never ending amount of inquiry opportunities that faced me each year. As a teacher, I will always be eager to learn more about the impact of curriculum on student learning and best teaching practices. This inquiry opportunity also helped me pause and reflect upon my own teaching beliefs. I look forward to developing more wonderings to research in future years in order to become a better educator not only for my students, as well as, for myself professionally.

I was not the only one feeling like I had a voice. My classroom atmosphere, during science time, was enhanced through the empowerment of students. Students were eager to make claims backed with evidence, as well as, share wonderings. I can still see Joseph, enthusiastically raising his hand with something to say. When I called on him, he smiled and said, "Mrs. Washell, not only do I have a claim to make, but I also have the evidence to back it up!" This became the dialogue of the classroom. Children were given voice to express themselves as thinkers of science. In having the opportunity to sit back and analyze what had occurred over the past few weeks, I noticed how they embraced the power of sharing what they learned, discussing wonderings, and designing experiments to obtain more data.

In researching the fundamentals of inquiry science, I discover that classroom atmosphere does play a major part in students feeling free to express their ideas without the fear of making a mistake. Nonjudgmental acceptance of student thoughts and ideas is instrumental in creating an environment in which all are comfortable with stating what they think. Over the years, I felt I maintained such an environment, but I now question what else I can do to further enhance student voice.

With claims, evidence, and wonderings becoming part of our daily conversations, I began to think about how the language of inquiry transcends science. Our KLEW chart about seeds and plants was full of claims, evidence, and wonderings. What other areas of the curriculum could be enhanced via inquiry? During reading, children make claims about text and are then required to provide evidence to support what they have learned. Preparing for our parent-student-teacher conferences, I asked my students if they could provide me with any evidence that they have met the goals they set the prior October. I wonder how my future teaching could change in general by incorporating inquiry ideas.

Not only did inquiry energize the children and I, Wisconsin Fast Plants proved to be a worthwhile resource for teaching plant concepts. Over the past few weeks, the students quickly entered the classroom in the morning. Before picking a lunch or hanging up their backpacks, they checked the plants. Many a morning, I would have several children gathered around the greenhouse discussing what they were observing. These observations led to claims, evidence, and wonderings in inquiry science.

Several years from now, I will once again set up my greenhouse and pull out those seeds we harvested years before. Wisconsin Fast Plants will once again be the subject of morning water cooler or greenhouse talk, but I will do things a bit differently. Since this was my first time growing these plants, I was hesitant to deter too much from plan, because honestly I was worried they wouldn't grow. Since I now know the seeds will grow, next time, I will take a chance. Maybe I won't thin one quad so children can see why we have to. Maybe I won't pollinate one set of flowers so we can talk about why they don't have seed pods. Next time, I know what to expect.

Education is in a constant state of change. New teaching practices emerge. New resources are tapped. New curriculum is written. I believe, as an educator, I can be part of this change. Through teacher inquiry, I do have the power to shape the future of education for the better.

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