CHILDREN AND DELICATE EMPIRICISM

by

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History of Science

Science has not always been a focus of school curriculum. During the nineteenth century math and science related topics began to make their way into the curriculum of European and North American schools, but they rarely attained the prominence given to reading and writing (Benavot & Kamens, 1991). Math and science both lagged behind other subjects in implementation of school curricula, but science lagged farther behind. The implementation of science as a core subject was often debated. There were three major objections to teaching science to the masses: 1) Science was viewed as unsuitable for the development of loyal and morally upright citizens, 2) Science was viewed as undermining religious belief and authority, and 3) Science instruction would inevitably subvert the existing political and social orders (Benavot and Kamens, 1991). However, by the close of the nineteenth century, the idea that math and science should be valued in school became more prevalent.

Kamens & Benavot (1991) reported that by the World War I, resistance to science education had weakened and most nations had incorporated some form of science education into their primary school curricula. Since the education community established science as a core subject, there have been many ideas and changes in how science is best taught by teachers and learned by students.

Elementary Science Curriculum Today

Even after science was viewed as important for all children to learn, there were and are still controversies about it. Science curriculum in elementary classrooms in the 1960's was based on uniform programs and two assumptions that included 1) if science is presented as scientists would do it, it will be interesting to all students; and 2) any subject can be taught to any child at any stage of development (Sandall, 2003). The 1970's brought about more diversity, philosophies, and types of materials, but, in many cases, science was taught at the end of the day, if there was time, by a teacher with little interest, experience, or training to teach science (Sandall, 2003). Science lessons often came, and still do come, from a text book and consisted of memorizing vocabulary, facts, and science truths. Elementary school science in the 1980's consisted of more of the same: students being taught to memorize science facts from a textbook. In the same way as in the 19th century when science was first coming to the forefront, reading, math and writing had more priority in the 1980's. However, in 1991, Benavot and Kamens found that the teaching of science and math were viewed as core knowledge. The National Science Education Standards (NSES) were developed in 1996 by the National Research Council and showed the need for changes in science education (Sandall, 2003). This document encourages scientific literacy, as does Sandall (2003) who said,

> Scientific literate students have the ability to apply scientific knowledge to aspects of their own life. This includes understanding of the basic concepts of science and the principles, laws, and theories that organize the body of scientific knowledge. It includes understanding the varied applications of science and modes of reasoning of scientific inquiry (p. 17).

Since the 19th century, science curriculum has come a long way; however some things have not changed much. Science is now considered one of the core subjects, but with the implementation of high stakes achievement tests, reading and math are still often considered more important and science is pushed aside.

In Texas, the Texas Essential Knowledge and Skills (TEKS) and the Texas Assessment of Knowledge and Skills (TAKS) dictate science curriculum. Each elementary grade level, beginning with pre kindergarten, has certain science standards to meet. Beginning in 5th grade, students are tested with a state level exam on science knowledge. The pedagogy of science is left up to school districts and the classroom teacher. In the Texas district where I currently teach, the science curriculum is vertically aligned across all elementary schools and grade levels. It leaves little room for teacher creativity and spontaneity and even less room for student choice.

Teachers use a wide variety of approaches of teaching science. Some adhere to a traditional view of teaching that assumes a child's knowledge corresponds to their reality. This approach involves using direct instruction, textbooks, teaching science vocabulary, and science truths. The teacher is considered the main source of knowledge. Krockover and McClelland (1996) describe a traditional view as knowledge that is in correspondence with reality.

A constructivist approach suggests that children's knowledge is in correspondence with their experiences and environment. Krockover and McClelland (1996) report that constructivism is based on the idea that children construct their own knowledge in an attempt to make sense of the world. Some constructivist approaches include inquiry. The inquiry approach assumes that students need opportunities to find solutions to real problems by asking and refining questions, designing and conducting investigations, gathering and analyzing information and data, making interpretations, drawing conclusions, and reporting findings (Bass, Blumenfeld, Fredricks, Marx, and Krajcik 1998). Teachers also use the 5-E model to teach science, which is consistent with the constructivist approach. The 5-E model is adopted by Texas as the science instructional cycle and requires the students to experience a phenomenon prior to any explanation and clarification by the teacher (Weinburgh, 2007).

Early Childhood Science

In many early childhood classrooms, teachers are required to allocate large amounts of time to reading and writing; therefore students' opportunities to learn science are limited. However, I found evidence that early childhood is the prime time for young minds to explore science.

In Jerome Bruner's representation of knowledge, children need opportunities to act on objects and opportunities to express their understanding through discussion or creating an image or picture of their understanding. Bruner believes that instruction should include a variety of appropriate materials that would enable students to represent their knowledge through actions, drawings, or words (in Howe & Jones, 1993). Teachers today must prepare children to develop thinking skills as well as develop scientific skills such as inquiry, discovery, and open-mindedness, and this must begin in early childhood.

In Gallestein's (2005) view,

> Hands-on/minds-on science teaching methods at the early childhood level promote thinking and communication through talking, drawing, drama, puppetry, and writing. With additional opportunities to question and communicate, children's development of language and reading skills improve as well as their

> science knowledge, resulting in the beginning stages of a scientifically literate population (p. 29).

Lev Vygotsky's social interaction theory also provides a key aspect in early childhood science learning. Vygotsky's idea of a more knowledgeable other in children's early learning, whether it is a teacher, a parent, or another student, is an important aspect of inquiry and discovery learning for early childhood students. According to Shepardson (1999), Vygtosky viewed children's understandings of natural or scientific phenomena exist in a social interactional way with language, mediating both children's social and individual psychological functioning: the way children see, talk, act, think, and know.

Delicate Empiricism

Reynolds & Weinburgh (2007) developed an approach to teaching science based on Goethe's delicate empiricism. Delicate empiricism is rooted in careful observation of a phenomenon in context over an extended period of time. An approach based on Goethe's ideas provides children with a rich experience of observing and investigating science phenomena. Reynolds (2007) argued that in addition to the traditional approach to teaching science, students should experience investigation and observation in the Goethean tradition. Reynolds (2007) also argued that this method of studying the natural world provides a way of approaching science that honors mutuality, context, and relationship and reunites a world that has become artificially fractured.

I used Reynolds and Weinburgh's model to find out if, in addition to traditional science instruction, their approach would lead to a better understanding of science for students. I implemented the "delicate empiricism" approach in a first grade classroom in a Fort Worth, Texas, elementary school.

Participants

The demographics of this elementary school were 57% Caucasian, 29% Hispanic, 12% African American, and 2% Asian/Pacific Islander and Native American combined. Forty percent of the students received free and reduced lunch. The total number of participants in my study was twenty-six, but because of some mobility in this school system, the total number of participants for which I have data is twenty-two. There were twelve female and ten male participants, ranging from six to eight years old.

Procedure

The plan for the year long study with the first grad class was to begin by planting Fast Plants. Fast Plants are a quick growing plant that go through the entire plant life cycle in approximately forty days. After the students experience the Fast Plants, we planned to adopt an outside plant around the school to watch, observe, and journal. Next we planned to plant a lima bean. At the conclusion of the study, we planned to read a book to the students based on the early papers of Joseph Priestly.

In the first week of October, parents and students were sent a letter inviting them to participate in the study. Permission forms were sent to parents and students. All forms were returned to me by the third week of October. I began the study in the classroom by administering inventories, which were adapted from the VNOS-C form (Abd-El-Khalick, Bell, Lederman and Schwartz, 2002), which assesses students' understanding of the nature of science. I explained the study to the students in our first class meeting. I told them that I am in school, just as they are, and that they would be helping me with a science project. In our next meeting, as a whole group we discussed observing and describing things. Each student was given a fresh green bean to observe and describe. We discussed the green beans and their qualities in detail in order to prepare the students to become careful observers. We discussed color, pattern, and behavior of the green beans. The students talked about their beans with a partner and described the beans in detail. Then we put all the green beans together and students tried to pick theirs out of the group. This activity helped students develop an appreciation for the need for good observational and recording skills.

During our next class meeting, the students and I planted Wisconsin Fast Plants. Fast Plants are a quick growing plant that goes through the entire plant life cycle in approximately forty days. The seeds are planted in Styrofoam boxes with four cells in each box. The boxes are placed on top of rectangular shaped plastic containers that are equipped with a water system so the plants are continuously getting water. The plants are then placed under florescent lights. After planting, we then watered the plants and placed them under the lights. Over the course of the next two weeks, the students observed their plants and recorded their observations in their plant journals. The students also discussed their plants with the other students at their tables.

During week two of the study, the plants sprouted and had leaves, and during week three the plants flowered and formed seeds. However, at this point the students drew the plants as they looked but did not write about the small changes in the plants.

During week four, our plants started dying, and, by week five, they were completely dead. We had several discussions about why our plants died, and the students recorded their ideas in their journals. During week six, the students dumped their plants out of the Styrofoam boxes and observed the soil and roots. We talked again about why our plants might have died. I asked the class what kind of experiment we could to do figure out why our plants died. We agreed to think about the issue and talk about it at our next class meeting.

After several minutes of discussion at our next class meeting, one student had the idea of planting more Fast Grow plants, then watering one group of plants and not watering the other group. We made plans to carry out our new experiment.

At week eight, we took a walk around the school to find an outside plant to adopt and observe. On our second walk, each student all chose a plant and then drew a map of where their plant was located.

Winter break came between weeks eight and nine. At our first meeting after the break, we went outside to check on our adopted plants. Most of the students remembered where their plants were located. The students noticed many changes in their plants, and they recorded their observations in their journals. Also, during week nine, we replanted three boxes of Wisconsin Fast Plants, and we decided that two boxes would get water and one would not get water. We talked about our experiment, and the students made predictions about what they thought would happen.

During the next four weeks when I went into the classroom, we either observed our experimental Fast Plants or we went outside to observe our adopted plants. We discussed how the Fast Plants that were not receiving water were not growing and the ones receiving water were growing and flourishing. The students observed their outside plants and recorded their observations in their journal. The students recorded the color, behavior, and pattern of their plants. The students were given a prompt to help them write about their plants: If my plant could talk it would say…

At week fourteen, the students examined and observed the Fast Plants. The plants had formed seed pods but were not ready for harvest.

At week fifteen, we went outside to observe our adopted plants and with the coming of spring, they had really changed. The students spent forty-five minutes observing the changes with their plants and then recorded their observations in their journals. The next three weeks were consumed by conferences, spring break, and student assessments so the class met for instruction only one time. We went outside to observe our adopted plants and then recorded the observations in the students' journals.

The week immediately after Spring Break, we went outside to check on our adopted plants. There were many changes since we had seen them last. Some plants had flowers and some had new "baby leaves." We also harvested the seeds from one Fast Grow plant.

During week nineteen, we planted lima beans in clear plastic cups. We made new plant journals and on the first page, the students described the process of planting the beans. The next week the students wrote and drew in their lima bean journals for the first time. Some beans were up, and some were not. We continued to observe our lima bean plants the rest of the week and some were not coming up. We discussed why the beans did not come up and decided to replant those on Monday.

During weeks twenty-one and twenty-two, we continued to observe the lima bean plants and record in the plant journals. We also continued to check on our outside plants and the students recorded their observations in their journals.

At this point in the study, the school year was nearly over. The students took their lima bean plants home. The TCU Science Education team adapted Joseph Priestly's early papers, which I read to the class and we discussed how the Priestly's experience related to their study of plants. Priestly's papers include his early experiments with plants and carbon dioxide in the late 1700's and early 1800's. Some of his papers were adapted by the TCU Science Education team in to a children's book.

I also conducted and video recorded some focus groups. There were three focus groups and there were from four to six students in each group. I conducted the focus groups in my classroom. I asked the students some of the same questions that were on the survey from the beginning of the study, and we discussed what they had learned about plants throughout our study.

Data Collection

I collected data through the student questionnaires (See Appendix A), student journals, videotaping, and focus groups. I administered the questionnaires at the beginning of the study do find out what the students knew about plants and the nature of science. The students kept individual journals for the Fast Plants, the lima bean plants, and the outside plants. The number of times the students recorded in their journals varied, but averaged three times per week throughout the study. I analyzed the journals and looked for themes and patterns in the students' knowledge and thinking about plants. I videotaped some of the journaling sessions to capture the discussions of the students. I used focus groups at the conclusion of the study and asked some of the same questions from the initial questionnaires in order to find out whether this study lead to a better understanding of plants for the students.

Results

Questionnaires

Before the project began, I assessed the students' thinking about science by administering a questionnaire (See Figure 1). I wanted to learn more about what they thought about science, scientists, and a few science related topics. I revised a science questionnaire (VNOS-C) into child friendly language, and with the help of the classroom teacher, Mrs. Carter, administered it to each student in the class. Eighteen students were given the questionnaire.

What is Science?
What do you know about Science?
How is science different from other subjects?
What is a scientist?
What do scientists do?

Will what we know about science every change?
How do scientists know that dinosaurs really existed?
How does the weatherman know what the weather will be?
How do you learn about science?
How would you like your teacher to teach science?

Figure 1

When asked, “What is science?” four students said something like science is an experiment. One student said, “It is where you try to figure something out and talk about it.” Three students believed science is art, and two said science is projects. Another student explained science as “work”.

When asked “What do you know about science?” four students said something like science is an experiment. For example, one student said, “You see what can float and what can sink.” Another student said,

> “I know it is fun. I used to take markers and water and make colors. You get to go places and don’t have to stay cooped up at one place.” Three students believed that science is learning, and two students said science is “cool””.

The third question was “How is science different from other subjects?” Two students said science is different because it is art and painting. Two students said science is plants. Two students said science is different because you “make something.” One student said science is different because “it is important.”

When asked “What is a scientist?” six students believed a scientist does experiments. Three students said a scientist is smart. Two students said a scientist is an artist. For example, one student said, “He (scientist) draws pictures, dressed like a doctor.” One student explained a scientist this way, “He can figure out even small things like mice.”

When asked “What do scientists do?” seven students said a scientist makes stuff, does stuff, or invents stuff. For example, one student said, “They (scientists) use glasses to see really small things and figure it out.” Another said, “Scientists do lots of things like save people and animals.”

The graph below (Figure 2) shows the results of asking the students the question, “Will what we know about science ever change?”

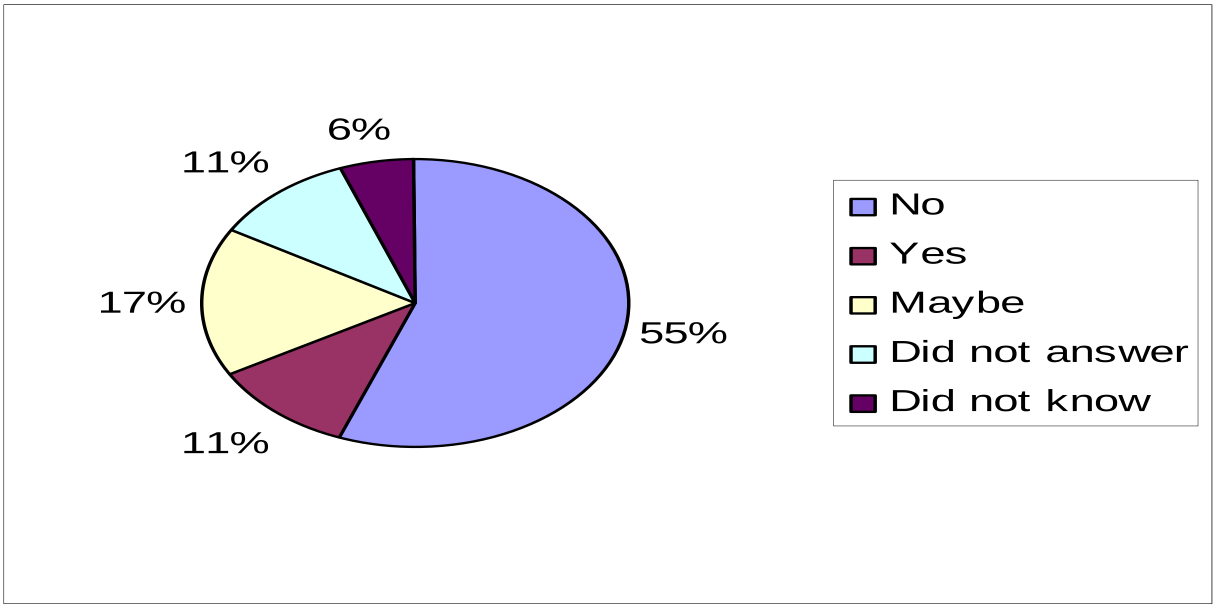


Figure 2

The seventh question was “How do scientists know that dinosaurs really existed?” Ten students said scientists know dinosaurs existed because they formed bones or fossils. Three students said scientists know dinosaurs existed because they are really smart. One student said, “They (dinosaurs) are loud and stomping hard and they are really big.”

The next question asked students, “How does the weather man know what the weather will be?” Six students said the weather man looks or goes outside to know what the weather will be. Two students said he checks the radar or his weather machine to know the weather, and two said the weatherman reads what someone else tells him to. One student said, “That’s a hard question. He has to study a lot. He goes to a special school. He looks at the sky and guesses it. Sometimes he guesses wrong. That doesn’t make it bad.”

When asked, “How do you learn about science?” seven students said they learn science from other people, like teachers or scientists. Two students said they learn science from their parents and two students said they learn about science from television.

The last question was, “How would you like your teacher to teach science? Five students said they wanted their teacher to use experiments to teach them science. Two students said being taught science would be good and make them feel glad.

Fast Plant Journals

Student Fast Plant journals were ten pages long and the journals had ample space for drawing and writing (See Appendix B). Students were asked to observe, discuss, and record what they saw in their journals, especially the color, behavior, and pattern of the plants. We also gave them this prompt to help get them started: "If my plant could talk it would say…"

I collected twenty-one student Fast Plant journals. The number of entries in each journal varied, but on average the students wrote in their journals three times per week.

Surface Features

The students seemed to report the obvious surface features about their plants. Eighteen out of twenty students reported that their plants were growing. Only two students reported their plant as not growing: one student reported it not growing two times and another reported it not growing one time (See Figure 3).

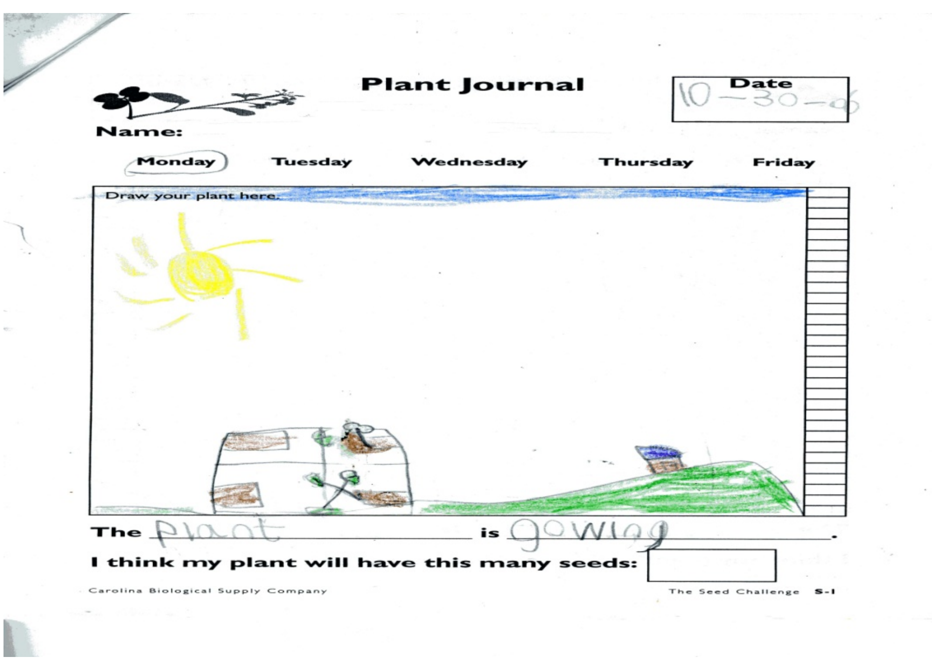
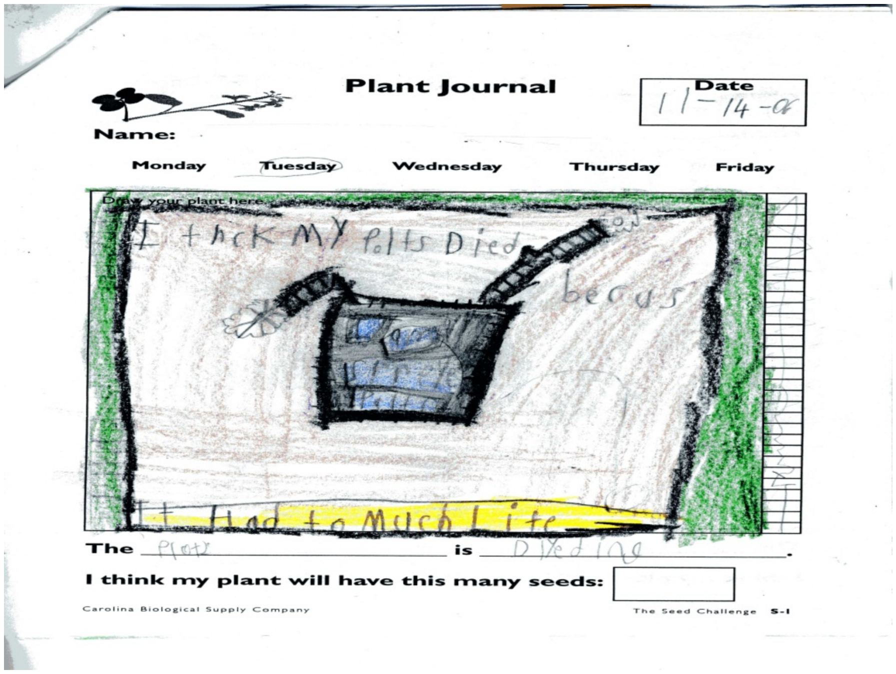


Figure 3

Students reported twelve times that their plant was big and six times that their plant was small or little. The students seemed to state the obvious about how their plants looked. For example, nine students reported that their plant was tall or long and nine students reported that their plant was green. A small number of students reported that their plant had a stem (2), flowers (7), and leaves (3).

Dead Plants

The majority of our plants died shortly after flowering and producing seeds, and more than half of the students reported their plant as dead or dying. No students reported this as the natural end of the plant life cycle. When our plants started dying, the students included many ideas in the journals about why they thought the plants were dying. Three students said their plant died because it didn't get enough water and two said it died because it got too much water. One student thought their plant died because it got old. Another thought it died from too much light (See Figure 4).


Plant Journal

Date 11-14-06

Name:

Monday Tuesday Wednesday Thursday Friday

Draw your plant here.

I thck MY Polts Died becaus

It Had to Much Life

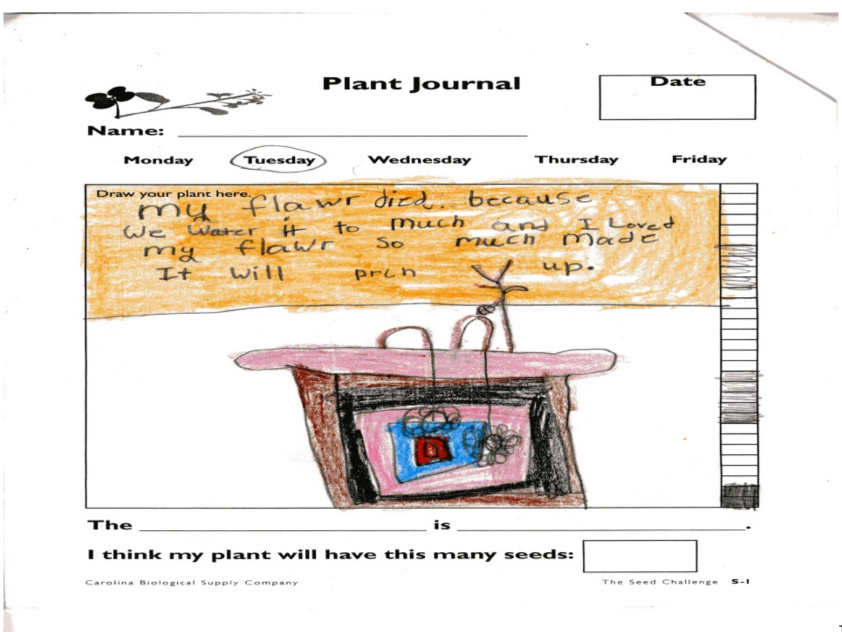
The Plots is Dieding.

I think my plant will have this many seeds:

Carolina Biological Supply Company The Seed Challenge S-1

Figure 4

A student told his plant, “I am sorry you had to die. You had too much air.” Two students believed their plant died because “we did not love on it” and another had hope that her plant would “perch up” (See Figure 5).


Plant Journal

Date

Name:

Monday Tuesday Wednesday Thursday Friday

Draw your plant here.

my flawr died. because We Water it to much and I Loved my flawr so much Made It will prch up.

The is .

I think my plant will have this many seeds:

Carolina Biological Supply Company The Seed Challenge S-1

Figure 5

Feelings

Some students described their own feelings about the plants. One student said the plant was his/her best friend and four students told their plant, “I love you”. Several students said their plant was happy, pretty, good, super, great and cool. One student even gave their plant a name. Only three students used the prompt to tell about the needs of the plant; one student said their plant needed more sun and two students said their plant needed water.

Drawings

The students were not able to write much about their plants, but they made up for it with their drawings. Half of the students drew detailed drawings of the plant and the plant box. Four students drew detailed drawings of the plants even when they were dying. The drawings showed the plants bent over and you could clearly tell from the drawings that the plants were dying.

However, some of the students seemed to draw what they knew about plants, instead of what they saw. Two students drew a sun in the sky above their plant and dirt on the ground below their plant and two students drew a sun and clouds above their plant (Figure 6).

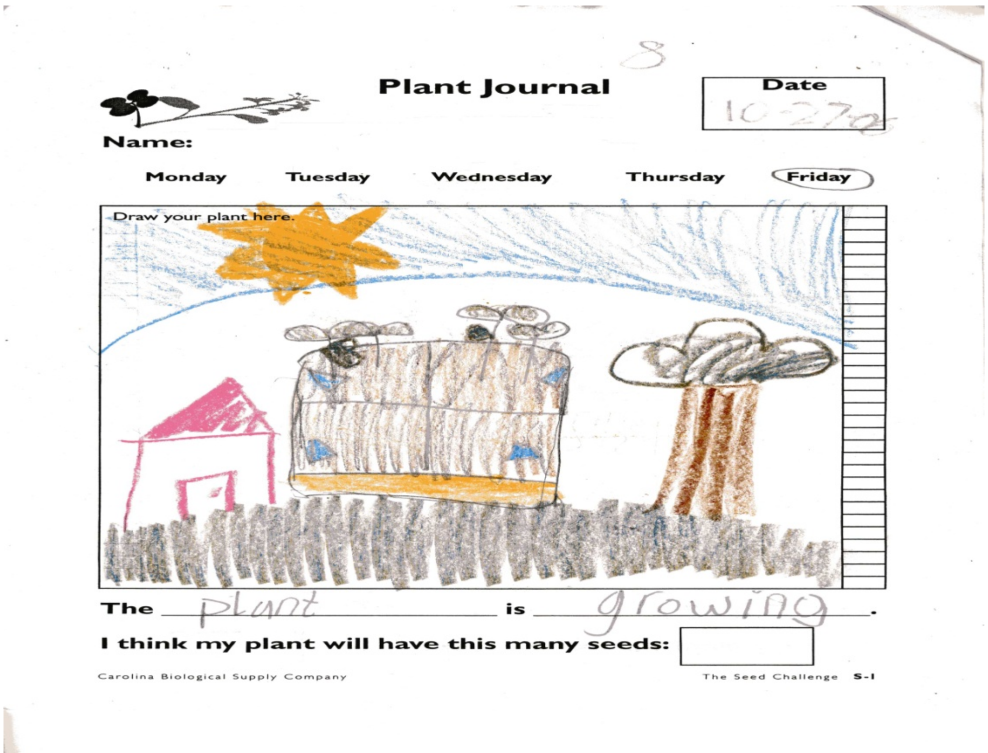


Figure 6

Four students colored the flowers on the plants a color besides yellow (all flowers were yellow). Two students drew roots, even though the roots could not be seen through the Styrofoam box. One student drew rain in their picture of the plant and another drew a bee.

Lima Bean Journals

Student lima bean journals were twenty-one pages long and had ample space for drawing and writing. The students were asked to observe, discuss, and record what they saw in their journals, especially about the color, behavior, and pattern of the plants. We also gave students this prompt to help get them started: "If my plant could talk it would say…" The number of entries in each individual journal varied, but on average the students wrote in their journals two times per week. There were sixteen student lima bean journals.

Drawings

The students drew detailed drawings of the lima bean plants. Three students drew detailed drawings of the seeds, the dirt, and the cup right after we planted the beans (See Figure 7).

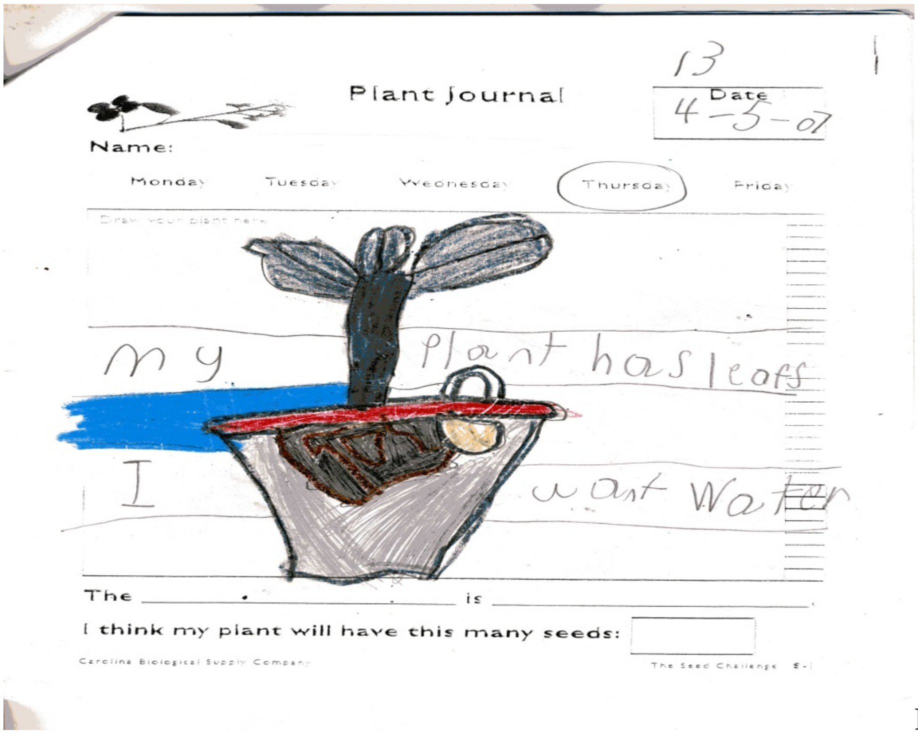


Figure 7

Fourteen of sixteen students drew detailed drawings of the plant and roots after the plants started growing. The students seemed to draw what they knew about plants instead of what they saw. All sixteen students, at some point in their journal, drew sunshine, clouds and sky in their picture of the lima bean plant. Four students also drew dirt on the ground and grass along with their picture of the lima bean plant, and two students drew clouds and rain. Nine of sixteen students drew clouds and rain at some point in their journals.

Surface Features

In the same way the students reported about the Fast Plants, the students stated the obvious surface features of the plants. Ten students described their plant as growing, while only one student described their plant as not growing (Figure 8).

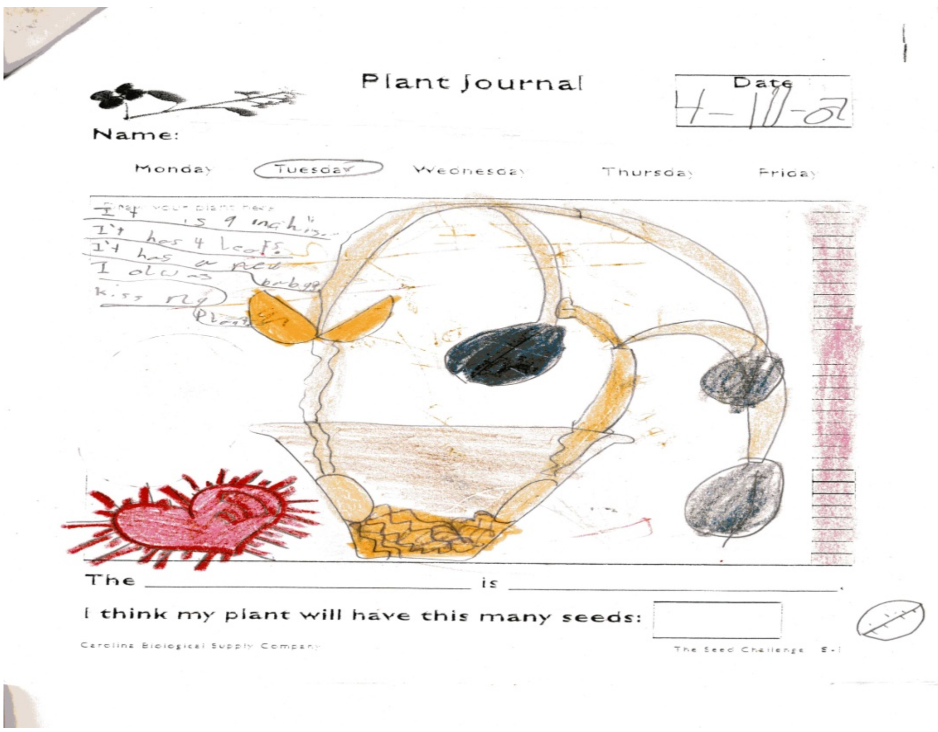


Figure 8

One student described their plant as white, describing the color of the lima beans themselves, and eight students described their plant as green. Three students said “If my plant could talk, it would say ‘I am alive.’” Four students described their plant as tall, and two students measured their plant. Two students reported that their lima bean plant was bending or down (See Figure 9).

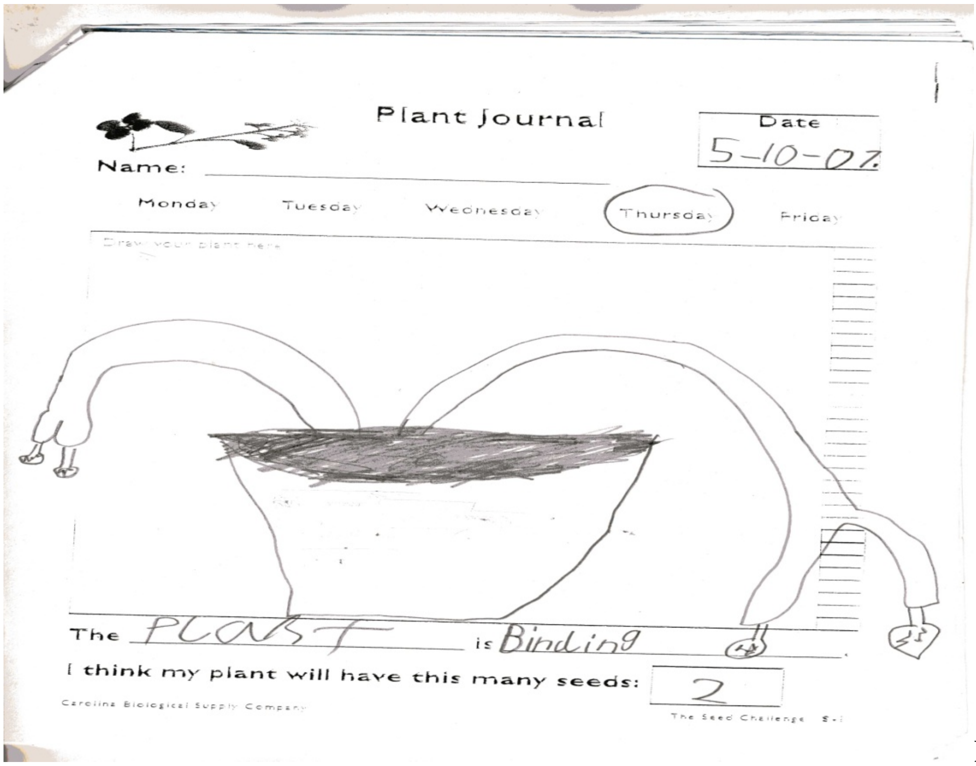


Figure 9

Three students described their plant as big. Six students reported that their plant had leaves: Four students described the leaves as green and one student even reported the number of leaves their plant had. One student described the leaves in this way: “My top leaf looks like a carrot.” Another student described the leaves as “ babies”. Two students reported that their plant had a stem.

A few students reported about the needs of their plant. Three students said their plant needed light or sun, and one student said their plant needed air. Five students said their plant needed water. One student described their plant as being “thirsty” (See Figure 10).

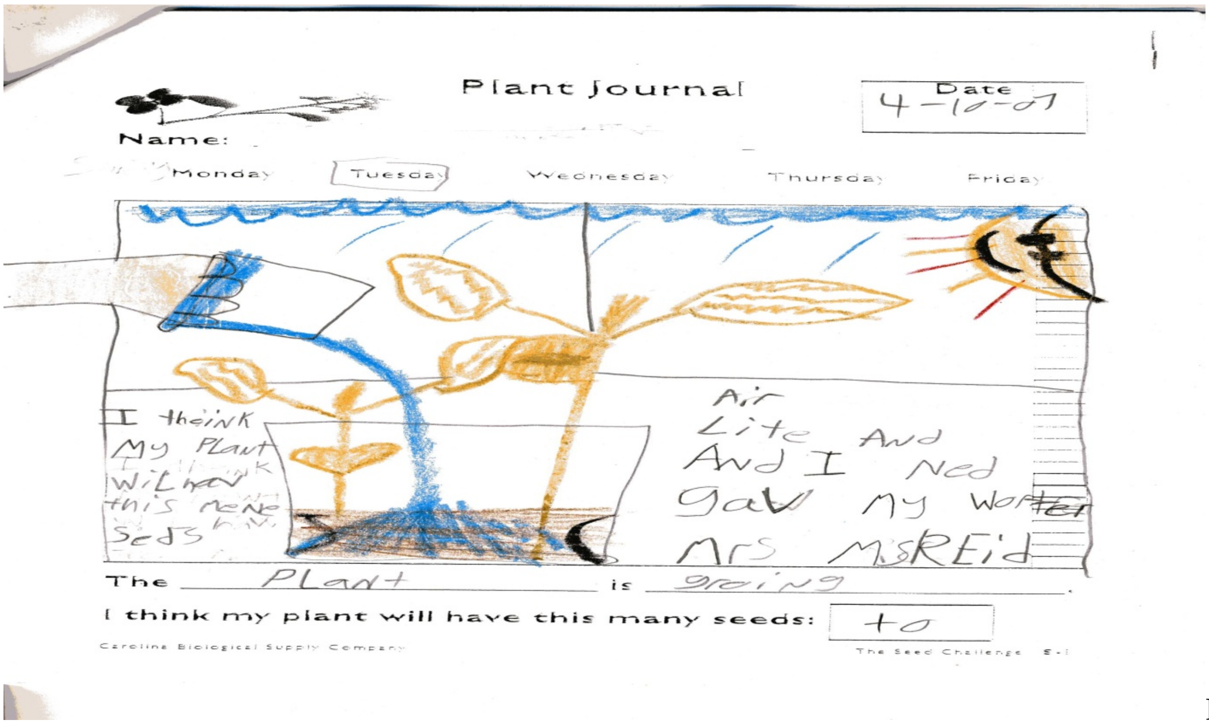


Figure 10

Feelings

Some students also described their own feelings about their plant. Two students said that if their plant could talk it would say, “I am cool.” Three students said they loved their plant, and one student said the plant was his “best friend”. Two students described their plant as pretty or beautiful. One student wrote to their plant, “I like you.” Another student said, “If my plant could talk, it would say my name.”

Outside Plant Journals

The students each adopted a plant outside the school building. The types of plants were limited to grass, trees, and shrubs. Student outside plant journals were eighteen pages long and had ample space for drawing and writing. The students were asked to observe, discuss, and record what they saw in their journals, especially about the color, behavior, and pattern of the plants. We also gave students this prompt to help get them started: "If my plant could talk it would say…" The students began to write in their journals in December and continued to write periodically through mid-May. The number of entries in each student journal varied, but on average there were seven entries per journal. I collected thirteen students outside plant journals.

Drawings

The students, once again, drew detailed drawings of their plants. Eleven of thirteen students drew detailed drawings of their adopted outside plant (See Figure 11).

Figure 11

Seven students included the sun and clouds or the sky in their drawing. Five students only included the sun, and three only included clouds or the sky. Only one student included the ground in a picture and colored it brown. The drawings differed from the Fast Plant journals and the lima bean plant journals. For example, five students included themselves (See Figure 12) along their plant in the journal, and three students drew other plants besides their own adopted plant in their pictures.

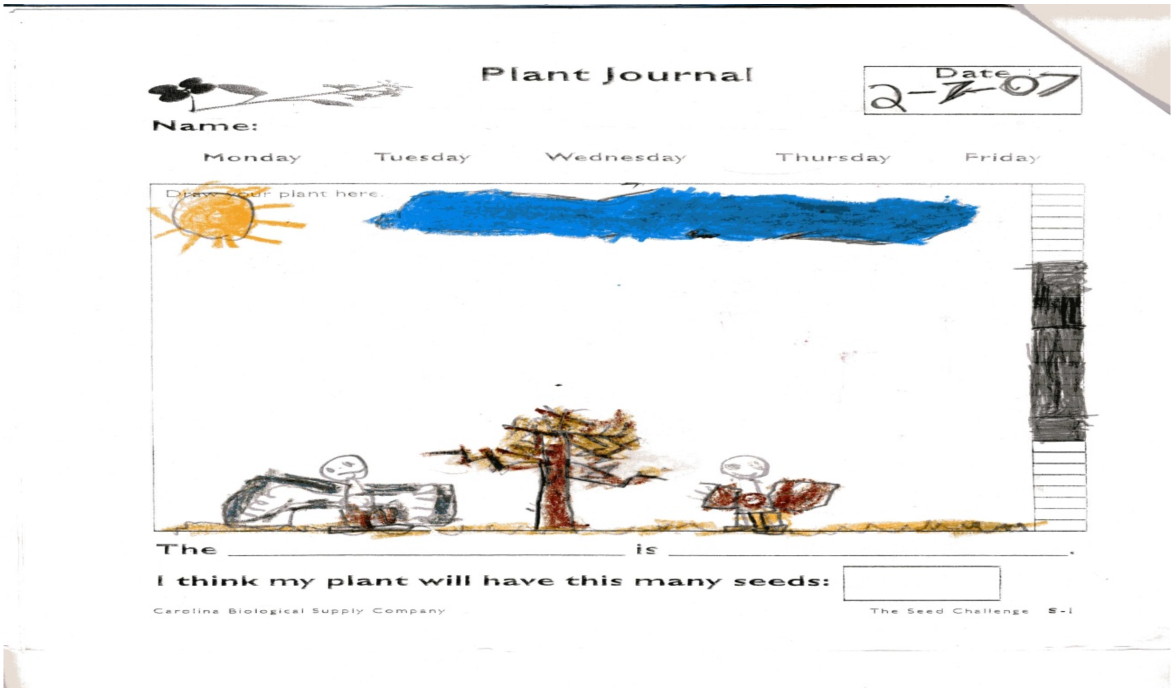


Figure 12

Four students drew a bee in their pictures and one student included one drawing with a bird and a ladybug. Three students included rain at some point in their journal.

Surface Features

Once again, the students reported the obvious surface features of the plant; however their journals for the outside plants seemed more detailed than the other two journals. Seven students reported that their plant was growing and one student said her plant had grown four inches. One student said, “I love my plant so it will grow and grow big.” Only one student said the plant was dying. Four students said their plant was green. Five students reported that their plant had leaves. One student described the leaves this way, “I have two baby red leaves.” Four students reported the color of the leaves and one student reported the number of leaves on the plant. Three students said the plant had flowers and named the color of the flowers. Two students said their plant was big. Three students described their plant as soft and one student described their plant as fuzzy. Two students reported their plant had a stem or stems. One student said the stem was long and another said their plant had green and white stems. Two students said their plant had changed (See Figure 13) or was different, and one student said their plant was not changing.

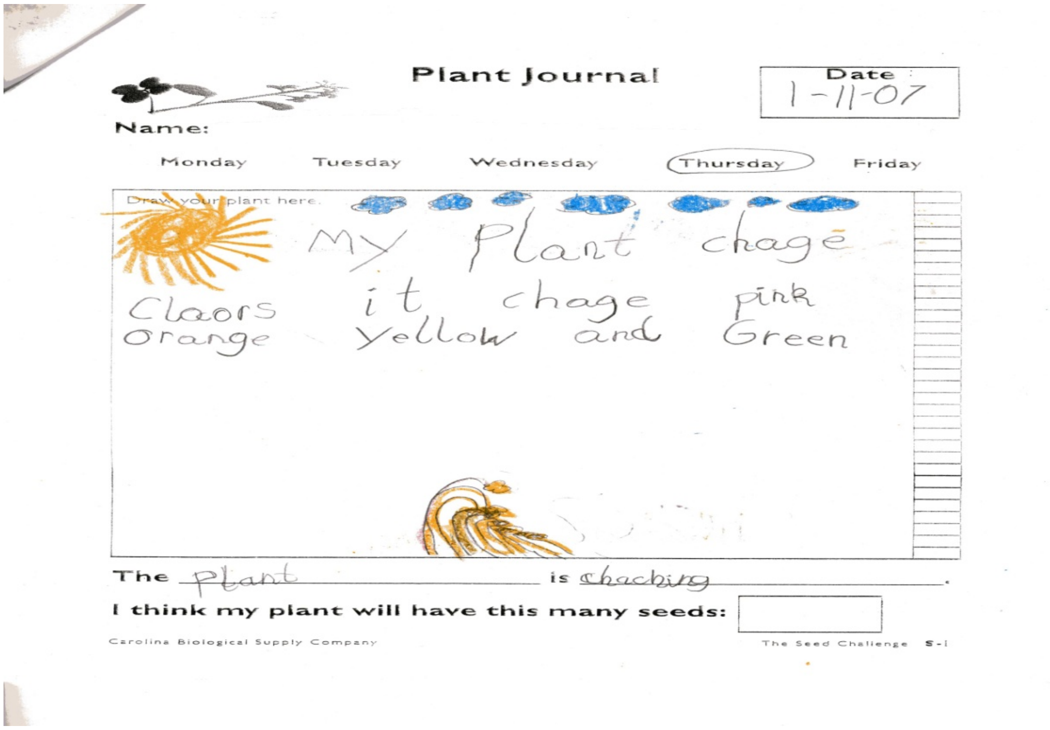


Figure 13

Feelings

Some students described their feelings about the outside plants. Four students said, “I love my plant.” Two students said their plant was “being good.” Two students gave their plant a name. One student said, if the plant could talk, it would say, “hi.” Another said if the plant could talk, it would say, “Happy Spring Break.”

Only two students talked about the needs of the plant. One student said their plant would say, “I’m thirsty.” Another student said their plant would say, “Give me water.” (See Figure 14) .

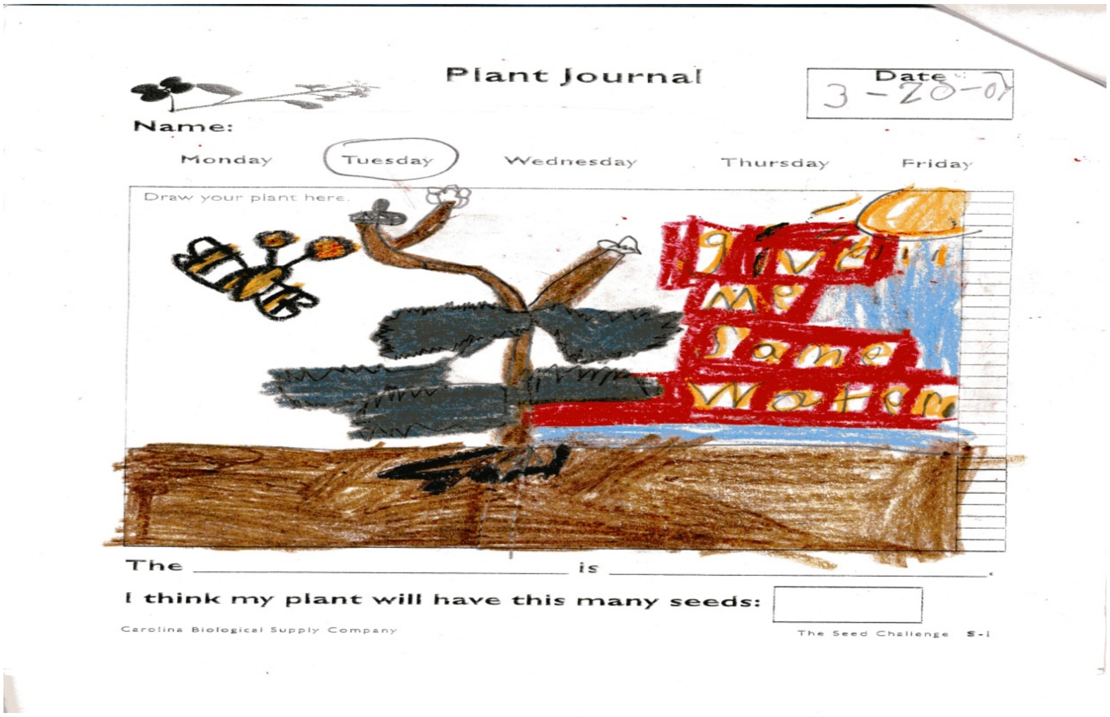


Figure 14

Focus Groups

At the end of the study, I conducted focus groups. I interviewed the students in three groups. The number of students in each focus group varied from four to six. I asked the students some of the same questions from the initial questionnaire as well as some questions about the Joseph Priestly story that I read to the whole class and some questions about the project in general.

When asked "What is science?" three students mentioned plants in their answer and one student said "Science is seeds". Three students also mentioned bones and fossils in their answer. One student saw science this way, “Science is when you don’t know what something is and you keep looking at it and working on it until you know what it is”.

I asked the students “What do scientists do?”, and the answers varied. One student said, “Scientists make potions”, and another said, “They make stuff”. One student said, scientists “discover stuff”, and anther said, scientists “find dinosaur bones and build them”. One student described what scientists do this way, “Science people are somewhere that is very secret and they don’t want to tell anybody and then they show people”. Another student said, “I am not a scientist, but I could be.”

When asked, “Will what we know about science ever change?” seven students said yes. One student said, “We learned new things about plants”. One students said, no because science is the most important thing”.

I asked the students a question about the story of Joseph Priestly and his early science experiments that I read to them at the end of the project. When asked “Did you have any of the same questions that Priestly did?" one student said yes and one student said no.

I asked the students if they liked our plant project. Two students said it was fun, and one said it was good. Another student said our project was very special. One student said, it's "very interesting that the plants don't grow and grow and then they grow and grow and grow." I also asked the students, "What did you learn about plants?", and the responses varied. One student said, "I learned that they die and if you don't put enough water just forget about it." Another student, "If you plant a plant in dirt and one night it will be dead if you don't put no water in it." One student said," I learned they grow kinda slow." Another student said, you "always have to put seeds, water, dirt, and sunlight."

When asked "What would you tell other first graders about plants?" three students mentioned that they would tell other first graders that "fixed" or bad air makes plants die. One student said, "Roses can change, like that story." One group of students said they would tell other first graders that plants always need seeds, sunlight, and water. One student said, “If you give water to them they will last a week.” And yet another student said plants need “seeds, dirt, and water or they will die.”

I asked the students to choose a color that would describe how they felt about our plant project. I felt it would be simpler for the students to describe their feelings by using a color. Three students chose green. Two students chose red and two students chose yellow. One student said he chose yellow because it is happy. Two students chose purple; one student chose purple because it is her “favorite thing”, and the other student chose purple because it was the color of his outside plant’s leaves. One student chose pink because it is a flower color and one student chose black for when the plant dies. Another student chose brown for dirt. One student chose blue and another student chose orange.

Discussion

Many changes have taken place since the 1900’s when science first became a core subject. Science is a core subject taught in elementary classrooms today, however I believe Goethe’s idea of “delicate empiricism” is a beneficial addition for teachers to use that will aid students in the understanding of science. Using Goethe's ideas, Reynolds and Weinburgh developed an approach that develops scientific skills such as inquiry, discovery and open-mindedness in young children.

My findings about whether an approach rooted in careful observation of a phenomenon leads to a better understanding of science in young children are based on a questionnaire, student journals, and focus groups. The questionnaires, administered at the beginning of the study, gave me a window to what the students thought and believed about science in general. The student journals gave insight on the student's knowledge of plants, the plant life cycle, and how they viewed the different plants observed. The focus groups, conducted at the conclusion of the study, brought to light the fact that the student's views of science did not change much from the beginning of the study to the end. However, at the end of the study, more students believed that what we know about science may change than believed that at the beginning of the study.

The study describes first graders year of observing plants. The findings indicate that first graders are capable of drawing what they observe and also drawing what they know. The findings indicate that the students are capable of drawing surface features of the plants and portraying their own feelings to the plants.

The focus group interviews indicated that the student's beliefs about science did not change much over the course of the study. However, more children believed that what we know about science may change at the end of the study than did at the beginning. The questionnaire did not ask specific questions about plants. I did ask more specific questions about plants in the focus group interviews, and the answers indicated that the students learned the basic needs of plants.

More research needs to be done using Reynolds and Weinburgh's method with young children. I believe that the detailed drawings of the children indicate their capacity to observe, and given more opportunities to engage in observation, discussion, and inquiry, they would be more likely to trust themselves as young scientists. As an elementary teacher, I think using this method to enhance a young students' science experience is beneficial. I encourage other elementary teachers to consider using this model along with their regular science instruction. The model is user friendly and can be implemented easily in a classroom and I believe the benefits will stay with the children for years to come.

VITA

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Experience	Kindergarten teacher, Littlefield ISD, Littlefield, Texas, 1997-2002
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ABSTRACT

I have presented the results of a nine month study in a first grade classroom, whether an approach to science, based on Goethe's "delicate empiricism" leads to a better understanding of science for young students. The study was done at a Fort Worth, Texas elementary school.

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Appendix A

Student Questionnaire

1. What is science?
2. What do you know about science?
3. How is science different from other subjects?
4. What is a scientist?
5. What do scientists do?
6. Will what we know about science ever change?
7. How do scientists know that dinosaurs really existed?
8. How does the weatherman know what the weather will be?
9. How do you learn about science?
10. How would you like your teacher to teach science?

Appendix B

Plant Journal

Date

Name: ______________________________

Monday **Tuesday** **Wednesday** **Thursday** **Friday**

Draw your plant here.

The ________________________ **is** ________________________.

I think my plant will have this many seeds:

Carolina Biological Supply Company

The Seed Challenge **S-1**