THE IMPACT OF SCIENCE NOTEBOOKS ON SCIENCE CONCEPT UNDERSTANDING IN THE LOWER ELEMENTARY CLASSROOM

by

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STATEMENT OF PERMISSION TO USE

In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE Program shall make it available to borrowers under rules of the program.

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July 2012

DEDICATION

This paper is dedicated to my current and future students. I hope that the research I've done will transfer to a richer, more successful science learning experience for them.

I would also like to dedicate it to my husband, Dan Devore, who has made countless dinners, taken on more than his share of housekeeping duties, and put up with my masters' work taking over our life for the past few years. You are the most patient, encouraging, loving person I know.

ACKNOWLEDGEMENTS

Acknowledgement and sincere gratitude go out to all of the people who have given me advice, support, and guidance throughout this process. To Walt Woolbaugh and Laurie Rugemer I give immeasurable thanks for their endless and patient support throughout this process. Their guidance and constructive criticism throughout this process has been essential. I so appreciate their dedication to helping teachers' improve their craft.

Another group of people I want to express my appreciation for are my support team. Scott McDowell, Tylene Walters, Tamara Engellant, Sid Rider, Linda Rice and Tina Colstad…….thank you for being the glue that held me together throughout this project. I am so grateful for all of the editing, ideas, and support you've given me. I am truly blessed to have such amazing friends and colleagues as you.

Finally, I give my sincerest gratitude to Superintendant Mary Ellen Fitzgerald for providing the opportunity to pursue my Masters. The professional development opportunities she provides are invaluable to my growth as a teacher, and I can't thank her enough.

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ABSTRACT

In this study, the use of science notebooks was implemented with 2nd grade students to determine their impact on student science concept understanding. It was found that notebook use increased student concept understanding. It was also determined that writing instruction improved the quality and accuracy of written responses, and that those improvements affected the success of student understanding and notebook content. This research has shown that lower elementary students benefit from keeping a science notebook.

INTRODUCTION AND BACKGROUND

Teaching science at the lower elementary level can be a rewarding, yet challenging task. There are many factors that affect the success or failure of science instruction with students at this age level. There needs to be a balance of curb appeal, content, and time. The sad truth is time often becomes the main factor in how science is taught at the elementary level.

In an effort to maximize the learning during the short amount of time I can allot to science during the school week, I have been trying to incorporate more inquiry opportunities over the course of the last three years. More and more I am realizing the tremendous impact this is having on student learning. I can't deny the value of student designed inquiries centered on questions they create themselves. However, that time factor keeps creeping in and making it increasingly difficult to adequately utilize this teaching/learning technique.

As a result of these observations, I have looked for ways I could incorporate other learning skills with this inquiry model, thereby buying myself a little more time to dedicate to instruction. In my pursuit of this goal, I discovered the science notebook. It seemed like a golden opportunity to combine writing skills and scientific process skills. My thought was that if writing skills could be practiced during science, I could ease back on the amount of daily writing practice I was doing, thereby increasing the amount of time I could spend on science.

I began to dabble with having students write about the investigations they were designing and conducting. During one particular set of investigations students performed on plants, I had an eye opening experience with one very inquisitive student. We had

been learning about plant needs, and small groups of students had chosen questions to explore based on their own hypotheses. One group wondered if plants really needed water, or if instead it could be any liquid. They decided to water a plant with vinegar to test this idea. Students wrote their question, hypothesis, plan, observations, results, and conclusion for the experiment.

After the experiment and investigation write-ups were completed, I conducted one-on-one interviews with students to assess their understanding and identify any misconceptions. It was after reading the conclusions of one of my students and conducting my interview with her that I became very excited about the idea of using science notebooks. She was really giving thought to why the plant didn't survive when they watered it with vinegar. She referred back to her notes when she was answering my interview questions. I wondered at that point how much having her write about it had impacted her thought processes and whether it would have any affect on her test score at the end of the unit.

It was this experience that inspired me to use science notebooks as my area of focus for this action research project. I designed several questions to help me determine whether science notebooks at the lower elementary level were worth the time and effort. Below I have listed my main focus question and the sub questions I have researched.

Focus Question:

What is the impact of science notebooks on students' science concept understanding?

Sub Questions:

How do science notebooks affect student attitudes about science?

How will the use of science notebooks impact my teaching?

What impact will expository science writing instruction have on student written responses?

After conducting this research, I hope to share the results with other interested teachers at my school. If students show significant growth in their scientific understandings and their writing skills, it is my hope that more teachers will be inspired to try them in their classrooms. By the same token, I hope to inspire others to try more inquiry methods in their science teaching strategies.

I will also be sharing the results of this project with my principal. Our school will be adopting a new science curriculum in the next year or two, and if inquiry and notebooks can be proven to be beneficial, there's a good chance we could adopt a program that utilizes them.

Throughout the process of this research, I had the help and advice of many supporters. My support team has been crucial in the development of my project and paper. The people on this team are:

Scott McDowell – Principal of Amsterdam School

Scott was new to our school this year and able to look at my project with fresh eyes. He was a first year principal, so this project became a valuable opportunity for both of us.

He was available to do observations, read through my writing, and provided critical feedback as I conducted my research. Our school will most likely be looking at a new science curriculum in the next year or two, so this also gave both of us some idea as to whether a curriculum that utilizes science notebooks would be beneficial for the whole school. Additionally, Scott has completed his own Masters program in administration and leadership which made him an invaluable resource as I worked through the steps of my own program.

Sid Rider – K-8 teacher at Past Creek Elementary School

I chose Sid to be on my support team because she has done Action Research in the past. She is also a good friend whom I have taken many professional classes with. She was able to give me a lot of technical support on the process of action research. She also had a strong understanding of what my write-ups should look like, and was able to provide me with constructive criticism that improved the overall project.

Linda Rice – recently retired K-8 teacher from Springhill Elementary School

Linda has been a friend and mentor teacher for many years. She has been retired for a year now, and is continuing to be involved in teaching. She is providing instruction in a few subject areas for some students this year. (When teaching is in your blood, you can never truly retire). Linda has a tremendous gift for asking me questions that got me to think deeply about my practices as a classroom teacher. She pushed me to analyze everything about my project carefully, helped me to discard anything that was unnecessary, and provided ideas to add to the project's success.

Tina Colstad – middle school teacher at Manhattan Public School

Tina is a colleague and friend who is an excellent writer. She has experience with teaching the 6 Traits Writing model as well as Step Up To Writing. She was an invaluable member of my support team when it came to helping me teach expository writing to my 2nd Graders. Her expertise helped me to review my writing for clarity and quality.

Tylene Walters – 5th grade teacher at Amsterdam School

Tylene and I are both currently working on our MSSE degrees. We have been sounding boards for one another throughout our participation in Science and Inquiry Learning in the Classroom (SILC) trainings and our current Masters coursework. Since we did our research on a similar schedule, and participated in the same discussions, she was an invaluable resource.

Tamara Engellant – Title 1 teacher at Amsterdam School

Tamara is our current Title 1 teacher. She has looked at many of my past assignments for proofreading and was familiar with my project. She also has some experience with using science notebooks. She contributed some resources while I developed the components I wanted to include in the notebooks. She too had a way of asking me questions that helped me to see things from new perspectives. Additionally, she has helped with the wording on my student attitude surveys to ensure that my students were able to interpret the questions and give useful responses.

CONCEPTUAL FRAMEWORK

Before I could design a method to research the effectiveness of science notebooks in my classroom, I needed to find out what others had done before me. After doing some extensive reading on the subject, I found support for the positive impact that science notebooks have been documented to have on student learning. The more I read, the more confident I became that this was the topic I wanted to research in my own classroom.

The articles, books, and studies I read gave me an overall impression that the use of science notebooks has been proven to be an effective practice in student learning as well as an assessment tool for teacher instruction (Ruiz-Primo, Li, Ayala, & Shavelson, 2004). Notebooks provide a way for students to show the evolution of their understanding of any given science concept. It gives them the opportunity to either change or add to their existing knowledge. In a study that synthesized research done on how we as human beings learn, the authors state that

Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom (Donovan, Brandsford, & Pellegrino, 1999, p. 10). The notebook would provide a means by which students could engage this prior knowledge on an individual basis. It would also be there for later reference as they developed in their understanding.

The studies I read strongly supported the notion that notebooks could support the building of new frameworks. This idea made me think about how well the use of notebooks connected with the constructivist theory of learning. Basically defined,

constructivism means that as people experience something new they internalize it through past experiences or knowledge constructs that have been previously established. "Learning occurs on the framework of what a student already knows" (Crowther, 1999, p. 18). If we are to believe Piaget's constructivist theory, then bringing current knowledge about a concept to the forefront at the start of new learning is crucial for students to develop any new understanding. The science notebook can be a vehicle for engaging that prior knowledge. It does not matter whether their conceptions are accurate or not as they begin their studying of a given topic. What matters is that they become aware of what they currently believe and can build on that in the formation of new understandings (Donovan et. al., 1999). The notebook provides a way for students to look at where they began and where they ended up in their thinking. Because it is written as they work, they don't have to rely on just their memory. They can make stronger connections and become more aware of their cognitive process which in turn helps them to synthesize the new knowledge with the old.

This theoretical basis supported my idea that science notebooks could be beneficial to students, even at the 2nd grade level. Since I was convinced that this was a worthwhile research pursuit, I needed to know more about science notebook components and implementation. Ideally, as Ruiz-Primo (2004) maintain, teacher training on science notebooks would have been best. Unfortunately, I was unable to find any workshops on the topic. So I dug into several articles and books that described effective components and techniques for implementation.

My reading helped me to understand that there were several key components that needed to be included in a science notebook. However, the key to success appeared to be frequent and effective teacher feedback no matter what components I decided on (Ruiz-Primo, et.al, 2004). After poring over several examples, I decided on the following set of components (Klentschy, M., 2008.).

Table of Contents
Notes
Investigation Write-ups
    Question, Problem, Purpose
    Prediction
    Plan
    Observations, Data, Charts, Graphs, Drawings, and illustrations
    Claims and Evidence
    Conclusion
Writing Prompts
Glossary

Of these components, the ones most crucial according to the constructivist model would be the question, prediction, claims and evidence. These would show me the best picture of the growth and development of each student's conceptual model. This was also supported by the results of a study of 72 students across eight middle school classrooms and five states that showed "…an indication that engaging students in the construction of explanations is likely to have a positive impact in students' learning and achievement of the content" (Ruiz-Primo, Tsai, & Schneider, 2010, p. 604).
All eight of the classrooms that participated in this study were taught the same inquiry unit on sinking/floating. The researchers found that the classrooms in which students provided strong explanations of their claims and evidence correlated with high performance on multiple choice tests, performance assessments, and short answer questions. From their analysis, they concluded that. "In general, we think that it is

reasonable to claim that focusing on at least one of the explanation components, claim, or evidence, seems to have a positive impact on students' performance" (Ruiz-Primo, Tsai, & Schneider, 2010, p. 604).

Yet, what would be the best way to do this with 2nd graders who often have a difficult time writing a complete sentence, let alone a paragraph about their metacognition of a topic? I was encouraged when I read Ruiz-Primo, et. al's study because their findings suggested that "focusing on one of the explanation components, claim, or evidence, seems to have a positive impact on students' performance (Ruiz-Primo, Tsai, & Schneider, 2010, p. 604). Klentschy's (2008) best suggestion for me was to provide a sentence frame that could support students' in their writing. For example, as we began writing up our investigations, I could give them sentence frames that look like this:

> I think _____will happen because_____.
> I noticed_____.
> _____happened because_____.

Because is the key word. All kids, but especially my young students, struggle to explain why they think as they do. They need a lot of practice with this before it becomes second nature. My hope was that by using the sentence frames, students would better formulate their thoughts and write in more detail. It would provide them with the structure they needed to focus their thinking and write in a more organized and detailed way.

Another set of articles that proved helpful guided me in developing some of the methodology for my research project. The main ideas I gleaned from these articles were 1) to have some sort of culminating writing assignment at the end of a unit (Beckstead, 2008), and 2) to engage students in a verbal discussion of the key concepts prior to that

assignment (Heuser, 2005). This would be a way to both assess student understanding, and track the development of students' writing skills over the course of the project.

I could have read for a year based on the amount of information that exists about this topic, but what I did read reinforced my desire to try science notebooks with my 2nd graders. Even though the level of writing skills could possibly be a hindrance, the picture the notebooks could present about student thinking was definitely worth some observation. As stated by Gilbert and Kotelman (2005), "Even students who may have poor writing skills can use visuals such as observational drawings and graphs/tables/charts to indicate their learning or even any misconceptions that may arise" (p. 31). So I jumped in with both feet.

METHODOLOGY

Treatment

After exploring the current literature on the topic of science notebooks, it was time to develop a treatment plan for my research. First, I selected two units of science in which to study the effects of science notebooks. During a unit about habitats, I did not use the notebook. I called this my non-treatment unit, and used it to help me establish some baseline data for the purpose of comparison. During a second unit about living things, I would apply the use of science notebooks which I called the treatment unit.

During the non-treatment unit, we began by reviewing new vocabulary. Students read meanings of the new words, looked at illustrations of them in their book, and discussed how the words could be used in sentences.

After this brief introduction, each lesson began either with small groups conducting a guided investigation from their textbook, or a self-designed investigation based on student generated questions and plans. Students worked in small groups to conduct these explorations. When finished, we verbally discussed the results. I did not allow them to record anything as they conducted these experiments.

The next step was to read the textbook lesson on habitats as a whole group. There was much discussion as we worked our way through the material. Then at the end of the lesson, students answered three questions. This was completed in written form which I collected and did not return to students. I kept each one for my data analysis later. Since I was not applying the use of the science notebook at all during this unit, I did not allow any written work to be kept by students to refer back to. The reason for this was I wanted to compare achievement on tests based on students not having access to their written

work during the non-treatment unit, and having access when they used science notebooks during a treatment.

At the end of the non-treatment unit, we reviewed the concepts we had learned in a whole class, verbal discussion. Then students completed a chapter test and a performance test. This habitat unit spanned eight lessons from November through January.

The living things unit in which I applied the treatment began in a similar way, but I added the use of the science notebooks. Throughout this unit, students were allowed to record anything that was useful to them in their science notebooks. They kept their investigation write-ups, notes, and writing responses in the notebooks and were allowed to refer back to them at any time.

For practice in writing up their own investigations, we discussed how to write each component. I gave each student an investigation write-up template. Together students designed plans for how to test the strength of paper towels. We practiced writing out each part of the investigation. I modeled how to do each component, and students copied it onto their template using their own thoughts and data.

The first item we discussed was the question. In this case, all students had the same question; which paper towel is the strongest? Then I modeled how to write a hypothesis. I used the sentence frame:

I think _____will happen

because_____.

I encouraged them to give me more than one reason for their thinking. When I finished modeling, students wrote their personal hypotheses on their investigation write up template.

After the prediction, I modeled how to write a plan. We talked about using numbers to put our steps in order. We discussed how detailed we needed to be. How to write a materials list was also presented. Then students completed this for themselves on their practice write-up.

Next it was time to train them how to record their observations. I showed them you could use sentences, pictures, tables, and graphs. I reminded them to date their observations and put as much detail into them as they could. As they performed their investigations, they chose appropriate methods to record their observations.

I had all of the students report their results, and we made a matrix of their information on our whiteboard. Since students had tried different methods for testing strength, they were able to observe different qualities that contributed to the strength of the paper towels. They noted which paper towel occurred the most on our chart.

At this point, they were ready to begin writing their claims and evidence. I provided another set of sentence frames to help them with these sections:

> The _____did _____. I know this because_____.
>
> Since_____happened, I believe_____.
>
> Now I wonder_____.

Students wrote their own responses in their notebooks, and then shared in small groups.

The final training piece was the reflection. I asked students to think about what their results would mean for their families. A sentence starter I suggested was:

My family should buy _____ paper towels because

_____.

In addition, I asked them to reflect on the process of their investigation. What would they change if they could do this experiment again?

When the initial notebook training was complete, I began to teach the first treatment unit. Students set up small group investigations based on student designed questions and experiments about plant needs. They recorded each step in their science notebooks. Then we shared our results with the whole group. Some of their questions were:

Do plants need water, or can they be watered with any liquid?

Sub questions: Can you water a plant with liquid? Pop? Grape juice?

Laundry detergent?

If you take away air, can a plant still grow?

Does a plant need sunlight or can a flashlight do the same thing?

If you coat a plant's leaves with sunscreen will it keep it from turning yellow?

When the investigations were complete, students stored their reports in their notebooks and wrote the investigation on their table of contents. Then, as I had done previously in the habitat unit, I introduced new vocabulary for the unit. This time, however, I had students record the meanings in their notebook glossaries, as well as a mini-illustration and a sentence using each word.

Next we started to read the information in our text about living things. I had students make a special page in their notebooks where they were to record any questions, thoughts, or wonderings as we studied the topic. I called this their notes. This is where they could park all of the ideas swirling around in their heads as we explored the science concepts for the unit. Every day throughout the unit, students were invited to record their learning from the day. This page was available at any time, so they were allowed to write in it at other times of their choice, as well.

After each lesson in the living things unit, students responded to three questions on paper. This paper was called a Think About It. This time, instead of discussing the questions verbally as we did in the non-treatment, they recorded their answers on a pre-printed worksheet that we added to their science notebooks as they completed them. They were allowed to access those writings, and anything else in their notebooks, at any time.

At the end of each chapter, we discussed review questions for the content, and they recorded their answers on paper. They included this in the notebook as well, and could refer back to any of it when they felt the need. Following the review, they took a chapter test and a performance test. This living things unit spanned five lessons from February through April.

Research Methods

The 2nd grade class I worked with on this project consisted of 23 students; 12 boys, 11 girls. Nine of these students qualify for free and reduced lunch (39%). Of these nine, two were very low in reading and writing skills, and four of them were above average in every subject as shown by their first report cards for the year.

The students in this class live in a small, rural community. There are 155 students who attend the school. They have a strong work ethic, and seem very eager to learn. As a school, 39% qualify for free and reduced lunch. The majority of the students are Caucasian, but there are three students who are second language learners. The school consists of K-6 students.

The science curriculum used with these students is the 2002 version of Harcourt Science. Each unit and lesson includes mini investigations followed by written concept information. After the unit is complete, a multiple choice, short answer, and performance test is provided. To supplement this curriculum, I provide additional opportunities for students to design and implement scientific investigations based on their own interests in a given science topic.

To assess my research questions, I came up with several measurement tools to help me understand the impact science notebooks would have on student learning, attitude, and writing skills. The research methodology for this project received an exemption by Montana State University's Institutional Review Board (IRB) and compliance for working with human subjects was maintained. Evidence of this approval is provided in Appendix F, p. 60.

In Table 1, I have listed my research questions and the measurement tools I used for each one. In order to increase the reliability and validity of these measurement tools, I applied the principle of data triangulation. I made sure that the tools I used could answer more than one of my research questions and provide me with data from many perspectives. A brief description of each tool is written below the table, and the actual measurement tools are in the Appendices of this paper

Table 1
Data Collection Methods

Questions	Attitude survey	Writing prompt rubric	Interviews	Chapter Tests	Performance Tests	Teacher journal	Quick Writes
Focus question:							
What is the impact of science notebooks on students' science concept understanding?	√	√	√	√	√	√	√
Sub questions:							
What impact will expository science writing instruction have on student writing samples?	√	√	√		√	√	√
How do science notebooks affect student attitudes about science?	√		√			√	
How will the use of science notebooks impact my teaching?	√		√	√	√	√	

Each of these tools served to help me determine how the notebooks affected student learning. The first tool, the attitude survey, was designed to give me an idea

about how students felt about science in general. Students were given a list of several questions about their feelings towards science. They had to choose whether the statements were rarely, sometimes, or often true. After each statement, they were asked to explain why they chose the answer they did.

To evaluate the quality of students written responses to comprehension questions I asked at the end of each lesson, I developed a writing prompt rubric. I used this rubric to evaluate written responses to Quick Write questions and Think About It responses. I used a four point system to evaluate their responses; four being the highest quality and 0 being the lowest quality.

To follow up the treatment unit, I conducted one on one interviews with three students. I chose one low achieving student, one medium achieving student, and one high achieving student for this process. I jotted down their ideas as we talked.

Another tool was chapter and performance tests that I gave at then end of each unit of instruction. This was an important tool for me because it allowed me to document student growth over time. After comparing scores from the two different units taught throughout the research, I could look for spikes, declines, and differences between non-treatment units and treatment units. I could also analyze changes in the performances of high, average, and low achieving students.

One of the most crucial tools was my teacher journal. I wrote in this as frequently as possible. The purpose was to record observations, thoughts, ideas, and questions that arose during the various lessons. I tried to write in the journal after every lesson, but that proved quite challenging. So I amended that to a few times a unit. This wasn't what I had hoped, but the reality of time just didn't allow for a daily journaling opportunity.

The next tool, Quick Writes, was not used on as frequent of a schedule. I used this as a spot check for student understanding. Periodically throughout the units, I would have students stop what they were doing and write for five minutes on everything they had learned about the current concept we were studying. The goal behind this assessment was to track what kinds of ideas were sticking in their minds. It also helped to identify misconceptions, and growth in understanding. Additionally, it gave my teaching more direction depending on their responses.

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Data Collection Schedule

When the measurement tools I planned to use were complete, I submitted them to the IRB committee and was approved. I developed a schedule of instruction and data collection. In Table 3: Treatment Schedule I have listed the dates, activities, and measurements I used during the research process.

Table 2
Treatment Schedule

Cycle	Activity	Measurement
Non-treatment Unit 1: Homes For Living Things November - January	Administer Science Attitude Survey	Attitude survey Teacher journal
	Chapter 1, Lesson 1 – Habitats for Plants and Animals	Writing Prompt Rubric Teacher Journal Quick Write
	Chapter 1, Lesson 2 – What Are Different Land Habitats?	Writing Prompt Rubric Quick Write Teacher journal
	Chapter 1, Lesson 3 – What Are Different Water Habitats?	Writing Prompt Rubric Quick Write Teacher journal
	Chapter 1, Lesson 4 – What Are Some Animal Adaptations?	Writing Prompt Rubric Quick Write

		Teacher journal
	Chapter 1, Lesson 5 – How Do Plants and Animals Help Each Other?	Writing Prompt Rubric Teacher journal
	Share findings from salt water vs. freshwater leaf experiments.	
	Answer Review Questions	
	Take Chapter 1 Test	Chapter 1 Test
	Do Chapter 1 Performance Assessment	Chapter 1 Performance test Teacher journal
	Chapter 2, Lesson 1 – How Does Weather Change Habitats?	Writing Prompt Rubric Quick Write Teacher journal
	Chapter 2, Lesson 2 – How Does Pollution Change Environments?	Writing Prompt Rubric Quick Write Teacher journal
	Chapter 2, Lesson 3 – How Do People Help the Environment?	Writing Prompt Rubric Teacher journal
	Answer Review Questions for Chapter 2	
	Take Chapter 2 Test	Chapter 2 Test
	Take Chapter 2 Performance Test	Chapter 2 Performance Test Teacher journal
	Administer Science Attitude Survey	Attitude Survey Teacher journal
Treatment Unit 1: Living Things Grow and Change February - April	Set up science notebooks. Teach students about the different components.	Teacher Journal
	Set up plant experiments. Students use science notebooks to record question, hypothesis, plan, observations, claims and evidence, conclusions, and reflections.	Teacher journal
	Chapter 1, Lesson 1 – Plants Grow and Change	Writing Prompt Rubric Quick Write Teacher journal
	Chapter 1, Lesson 2 – How Do Plants Grow and Change?	Writing Prompt Rubric Quick Write Teacher journal
	Chapter 1, Lesson 3 – How	Writing Prompt Rubric

	Are Plans Alike and Different? Answer review questions for Chapter 1.	Teacher journal
	Take Chapter 1 Test	Chapter 1 Test
	Take Chapter 1 Performance Test Student interviews	Chapter 1 Performance Test Teacher journal Student interviews
	Chapter 2, Lesson 1 – Animals Grow and Change	Writing Prompt Rubric Quick Write Teacher journal
	Chapter 2, Lesson 2 – What Are Some Animal Life Cycles? Answer review questions for Chapter 2	Writing Prompt Rubric Teacher journal
	Take Chapter 2 Test	Chapter 2 Test
	Take Chapter 2 Performance Test Student interviews	Chapter 2 Performance Test Teacher journal Student interviews
	Administer student attitude survey.	Attitude survey

When the research methods and data schedule were in place, it was time to implement the project. Since I alternate weeks of social studies and science instruction, approximately 6 months were utilized for the treatment and data collection. With this completed, the next step was to begin data analysis.

DATA AND ANALYSIS

Once the treatment plan and research methods were in motion, it was time to look at the data more closely. Somewhere in the piles of numbers and stacks of students' writing were the answers to my questions. What effects would science notebooks have on my students' science concept understandings and writing skills? Would they prove to be a tool I should add to my teaching repertoire? How would their use affect student attitudes towards science?

In search of these answers, I spent many weeks analyzing all the data from my class of 23 participating students; 12 boys and 11 girls. For comparison purposes I looked at patterns in the whole group, as well as between ability groups. The ability groups were determined by overall academic performances during the first few weeks of school. Eleven students fell into the high performance group that averaged 85-100% on most of the work they turned in for a grade. Seven students were in the average performance group of 70-84%. The other five students were in the low performance group that averaged below 70%.

After determining my comparison groups, it was time to sort through all of the data. I found some solid evidence that the use of science notebooks had made a positive impact on students' concept understanding. A strong indicator of this impact was the change in scores on chapter/performance tests. The class average scores showed a definite overall increase in student understanding. When looking at all 23 students who participated in my research, the overall class average scores on tests increased from 84-91%. This was a 7% increase. Figure 1 illustrates the change between all 4 tests given during the non-treatment and treatment chapters.

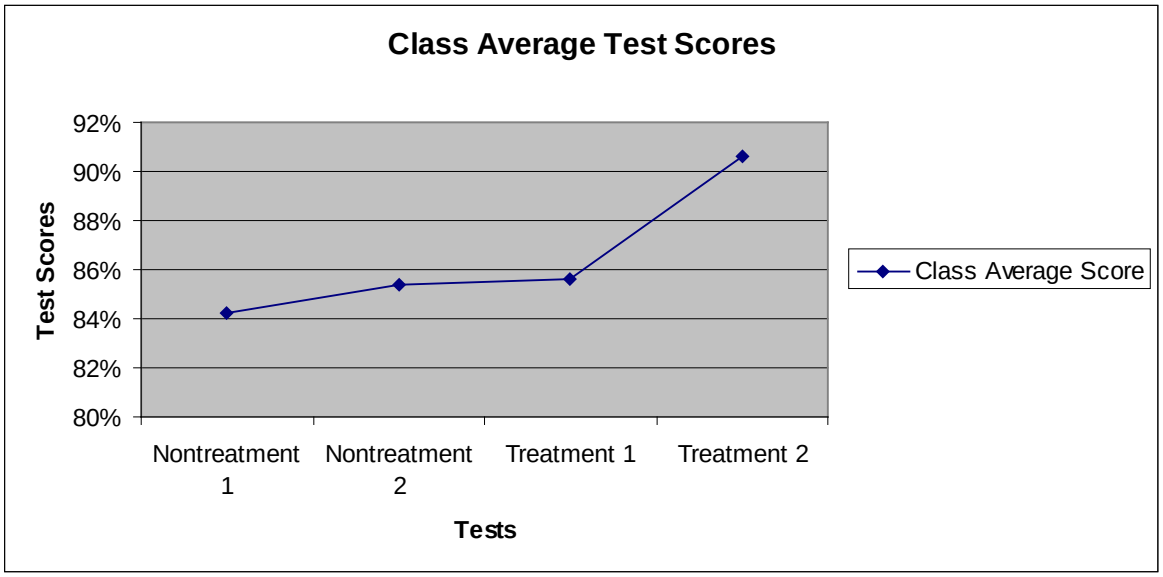

Figure 1. Test Averages, (*N*=23).

A significant class average increase occurred between the first and second tests given during the treatment cycle. Based on comments they wrote on their attitude surveys, part of the reason for this may be that they understood how to use the science notebooks more effectively. One student made the comment, "It helps me learn science because I can look back and I remember it better." A teacher journal entry I wrote during the treatment cycle attests to this as well.

> Several students referred back to their diagrams of a chicken's life cycle today when I asked them the stages. Many were able to say it verbally, and when I asked how they knew for sure, they referred back to their notebooks. It was pretty cool, and they seemed to feel proud that they thought of their notebooks to help them answer the question (teacher journal, 11/10/11).

This idea that notebooks were a good memory tool was commented on by several students on the attitude surveys. Even my low students shared comments like, “Science notebook is great for me because I can learn more stuff that I remember.”

Knowing that the class as a whole had improved their test scores once the treatment began was encouraging. I was also curious about how it affected my higher level, average, and lower performing students. So I took the data I had collected and sorted student scores into those three categories. I was encouraged to see that all three groups showed gains in their concept understanding according to their test scores. Figure 2 shows the results from the four tests plotted by group levels.

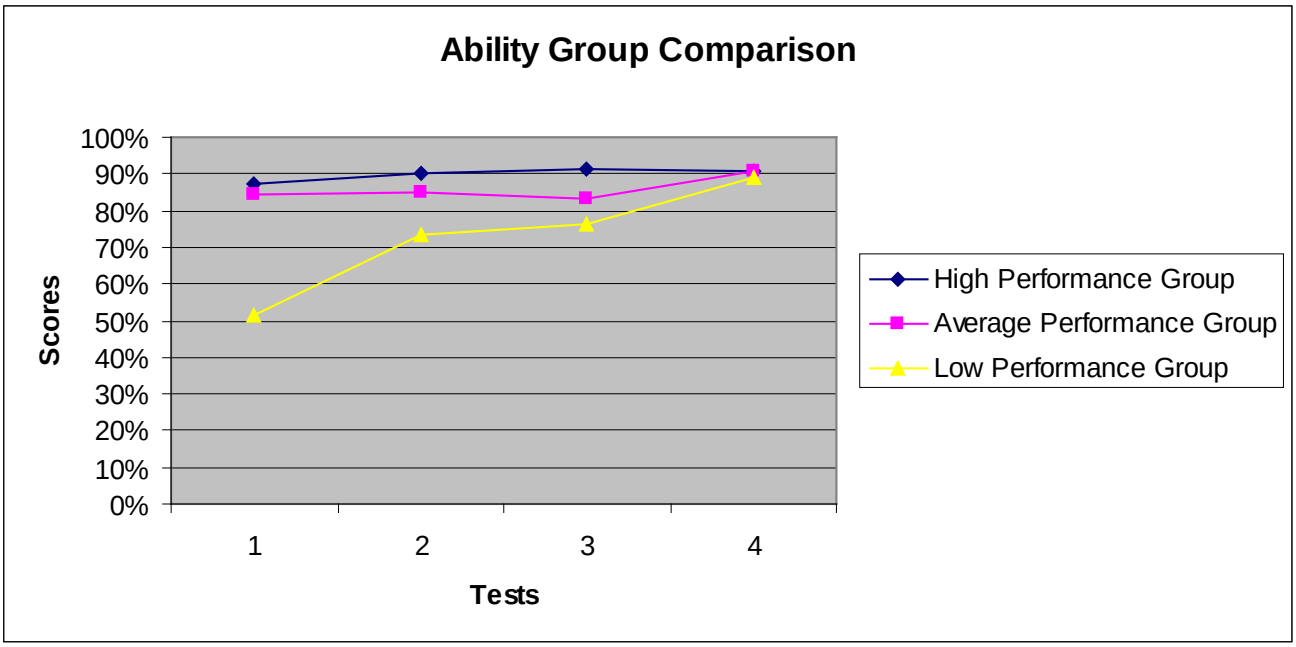

Figure 2. Ability Group Test Averages, (*N*=23).

Tests 1 and 2 were given during the non-treatment cycle, and tests 3 and 4 were during the treatment cycle. You can see quite a difference between the beginning scores of the average and high performance groups compared to the low performance group. As we worked through the units, I found that the low performing group surprised me the most. I

had predicted that they might show the least growth due to their writing challenges, learning struggles, and the fact that there were so few students in the group. My prediction turned out to be wrong. In fact, they showed the most growth. Perhaps this is because of the fact that they had the most room to grow. As a group, they went from a 52% test average at the beginning of the non-treatment cycle to an 89% test average at the end of the treatment cycle. That's a difference of 37 percentage points which I find quite significant. I was worried at the beginning of this process that the quantity of writing would be so taxing for this group, that I wouldn't see much change in their test scores. I'm very excited about the way this turned out.

As I read through the low performance group's comments on their surveys, they supported this numerical representation of their success. My most learning challenged student stated, "Science notebook is great for me because I can learn more stuff that I remember." The other four students in this group wrote similar thoughts on their surveys.

There were other factors that I'm sure contributed to the success of these lower performing students even though they weren't measured during this research project. The growth in their reading, writing, and math skills over the course of the year has been pretty amazing. I feel this was due mainly to the fact that three of the five students received 45 minutes to 2 hours of intensive one on one help in reading, writing and math per day. I know that this helped in all areas of their learning, and is a testament to the skill of our Title teacher Tamara Engellant. Her support aided these particular students in all areas of their learning. The notebooks then were an important component because they gave these students practice on the skills they were struggling with, as well as a place to showcase their growth.

The high and medium performing students showed less significant growth, but growth none-the-less. The high performing students started at a group average of 88% and ended at 91%. The average kids started at a group average of 84% and ended at 91%. A claim I could make based on this data is that while science notebooks are useful to all students, they may serve lower performing students the best.

Another observation I had was that by the end of the process, my students were all right around the same test averages. We ended with the high and average performing groups averaging 91%, and the low performing group at 89%. It seems that the notebooks have balanced out the performance levels of my class on the whole, and at a high achievement level.

While the test scores gave me a window into overall understanding of the science concepts I was teaching, I wanted to look at other measures to validate those results. So I looked at the data I had collected from the Quick Writes given during the units. Quick Writes were given periodically throughout the research to see what concepts students were recalling. I used them at the end of a lesson for students to unload everything they'd learned. They simply wrote for five minutes about everything they'd learned from the day. They weren't allowed to look back at notebooks or textbooks for recall.

I used a four point writing response rubric to determine the quality and accuracy of students' written responses. Students could score 0 – 4, four being a very high quality response. For me, it's easier to compare percentages, so if students earned a four, they got 100%. A rubric score of three was equivalent to 75%; a two was 50%, a one was 25%, and a zero was 0%.

As you can see in Figure 3 there was a telling difference between the non-treatment Quick Writes and the treatment ones.

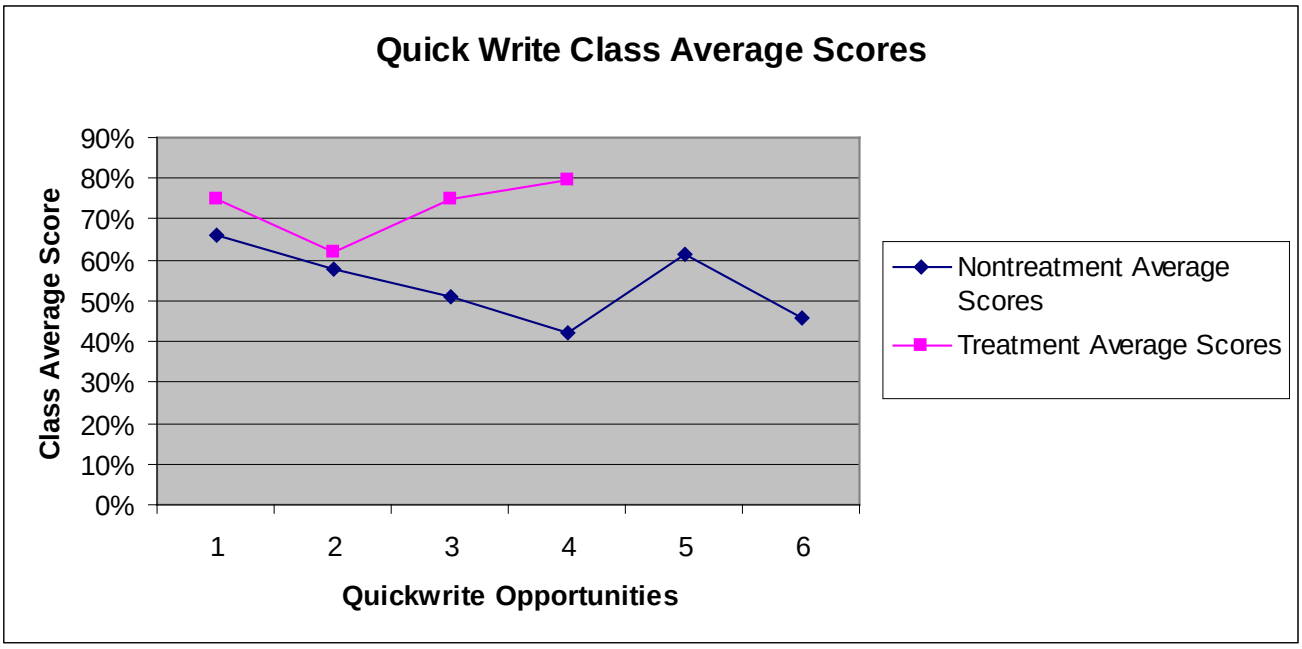

Figure 3. Quick Write Writing Prompt Averages, (*N*=23).

During the non-treatment period, students were not using notebooks, nor did they have any expository writing lessons. This resulted in a downward trend. The Quick Writes were intended to show me which concepts were clear and what misconceptions they were having so that we could address any issues in the following science session. With lack of writing lessons, it was difficult to determine just on paper what students did and did not understand. This made it troublesome in the sense that they didn't give me the best information I could get for lesson planning purposes.

Although there were fewer opportunities for Quick Writes during the treatment cycle, the average scores started at a slightly higher percentage and increased consistently throughout the treatment. This matches the upward trend of the treatment test results shown previously in Figure 1 above.

I believe that writing instruction played a role in improving these scores. After a few lessons on how to write a paragraph with a topic sentence, and details that support it, I began to see the quality of the Quick Writes go up. We practiced restating the questions and adding reasons for our thinking to our responses. The more practice they had with this, the better their responses became, and I was better able to understand their knowledge. An entry from my teacher journal supports this idea.

> As I analyze student responses on attitude surveys and on Think About It questions, I am noticing some restating the question when they write their responses. We have been working on restating questions and how to write paragraphs during Reading and Writing instruction time. (Not related to science) It is exciting to see that they are beginning to apply this in their writing (teacher journal 11-2-11).

This could have also influenced their test performance since I was getting a better understanding of their needs. It guided my lessons to what they needed more work on, which then resulted in better test scores.

The ability group scores showed some interesting trends as well. Figure 4 shows how the three performance groups compare to one another.

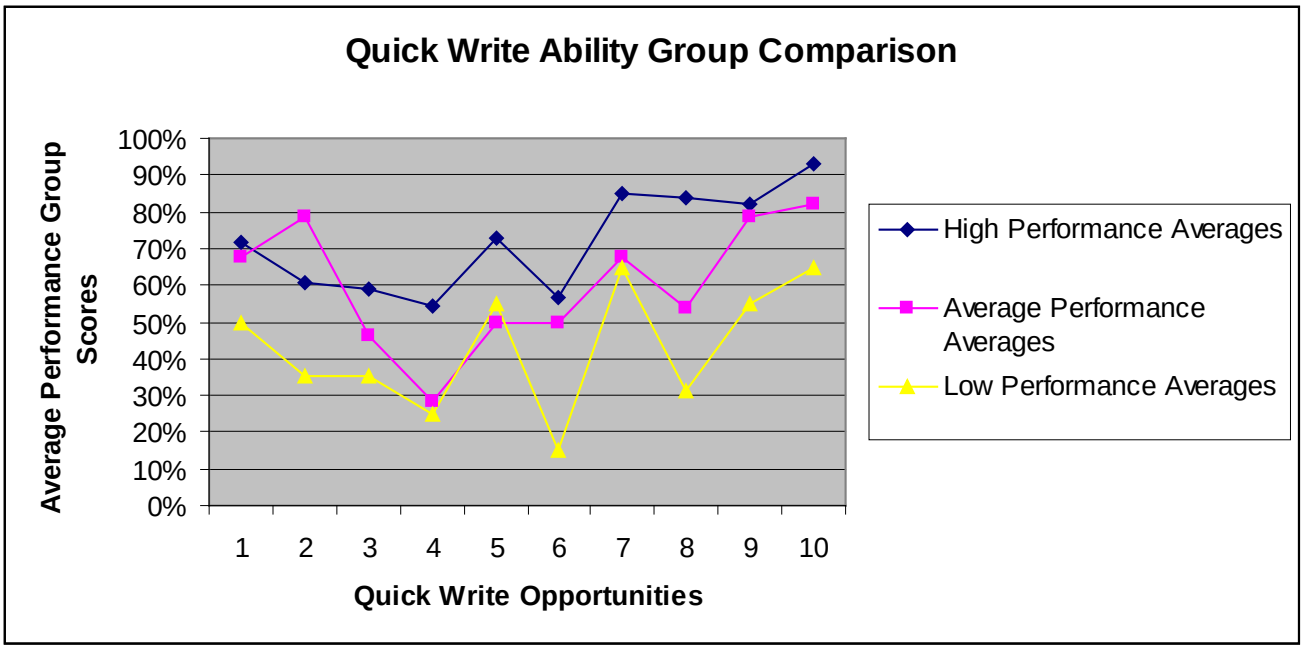

Figure 4. Quick Write Ability Group Comparison, (*N*=11 for high performance, 7 for average performance, and 5 for low performance).

All the group averages increased over the course of the research. In this case however, the higher performance group showed the most growth. They began with a group average of 71% and ended with an average of 93%. This end number correlates to their overall test performance average of 91%. It suggests to me that writing their learning down during each lesson contributed greatly to their concept understanding.

The average performance group was more erratic, but by the end had reached from 68 – 82% success on the Quick Writes as a group. I think this may have been due to more focus during instruction time, which the notebooks have helped with a great deal. I noted in my teacher journal in January that the kids seemed very motivated to learn science because of the notebooks.

> I can't believe how excited the kids get when I ask them to get their science notebooks out. They feel so important when they get to use them. Today I asked them to get their science books out and they were so disappointed. I think they like their own notebooks because its "theirs" (teacher journal, 1-18-12).

The comments students have given me about being able to remember things better because of the writing, as well as my own journal notes support this theory and seem to match the graph, too.

> We've been practicing how to restate questions in our reading comprehension responses, and that has been carrying over into how students answer the Quick Write and Think About It responses as well as the last Attitude Survey. Even my low performing students are developing skill at using complete sentences. The low group's "because" responses aren't always logical, but the fact that they are beginning to grasp how to begin a statement is hopeful (teacher journal, 2-4-11).

With such strong supporting evidence that science notebooks were helping students to understand science concepts, I wanted to dig a little further. Beyond concept understanding, how would writing instruction affect their science writing samples? Would there be more clarity? Could they communicate their understandings more effectively?

To measure their growth in this area, I relied heavily on written responses to questions from each lesson. I called these Think About It questions. After each lesson, I gave students three questions to answer about the lesson. I used the same scoring rubric I'd used on the Quick Writes, but Think About It papers were worth 12 points total. (Each of the three questions could earn up to 4 points).

Unfortunately, there were not equal numbers of lessons between the non-treatment unit and the treatment unit. However, I think as you observe Figure 5, you will notice a significant difference between the class performance over the course of the research.

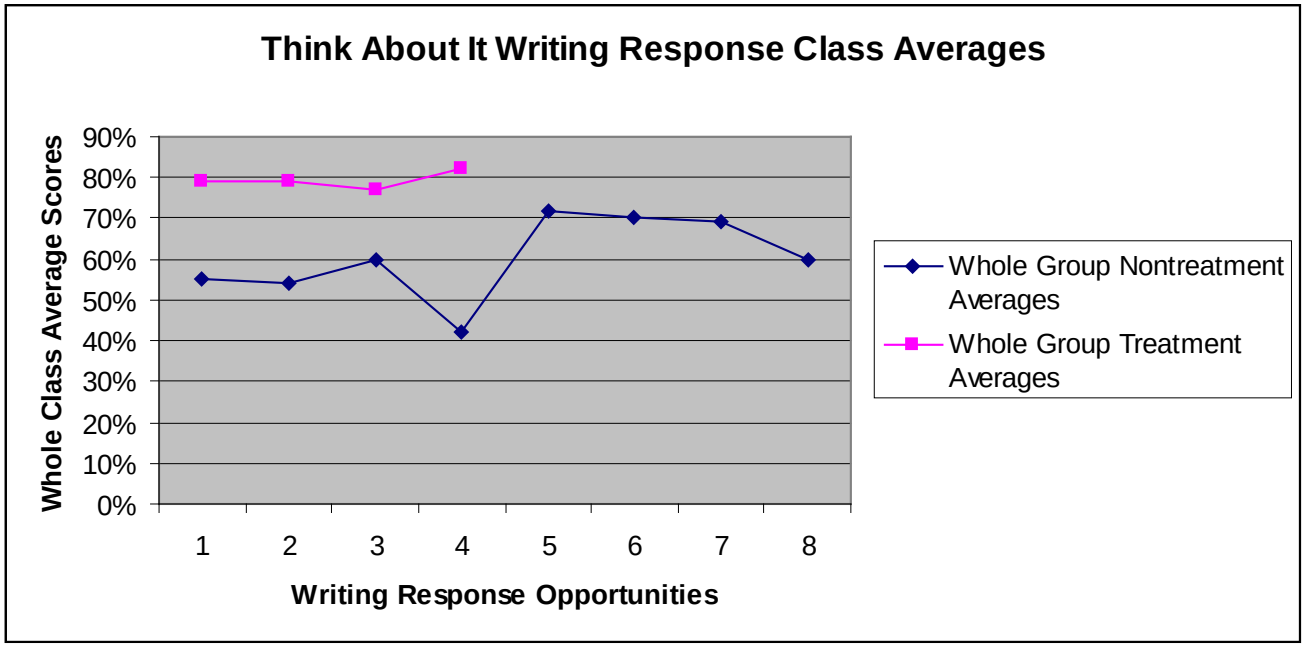

Figure 5. Whole Group Writing Responses, (*N*=23).

The non-treatment responses averaged 55% to begin with. It actually surprised me that the class average was so low given that I have such a large percentage of students who perform average or above on most of their work. However, expository writing is always challenging; especially for young students. As we progressed through the non-treatment lessons, their averages were up and down, ending with a 60% average. It was progress, but not high enough achievement for my taste.

After the initial training on how to answer their questions by restating the question and adding details, you can see that their average scores went from 60% at the end of the non-treatment to 79% at the beginning of the treatment. I was actually

disappointed in myself for carrying the non-treatment on as long as I did. Based on the fourth treatment Think About It results, the writing instruction definitely improved their averages. The class as a whole finished at 82% at the end of the treatment.

The ability group averages were able to show even more significant change. For this I used two different figures to illustrate the change. Figure 6a shows the jagged pattern of scores for the three groups. Figure 6b gives you a picture of how those scores leveled out for all three groups, and demonstrate a higher performance level for all three groups.

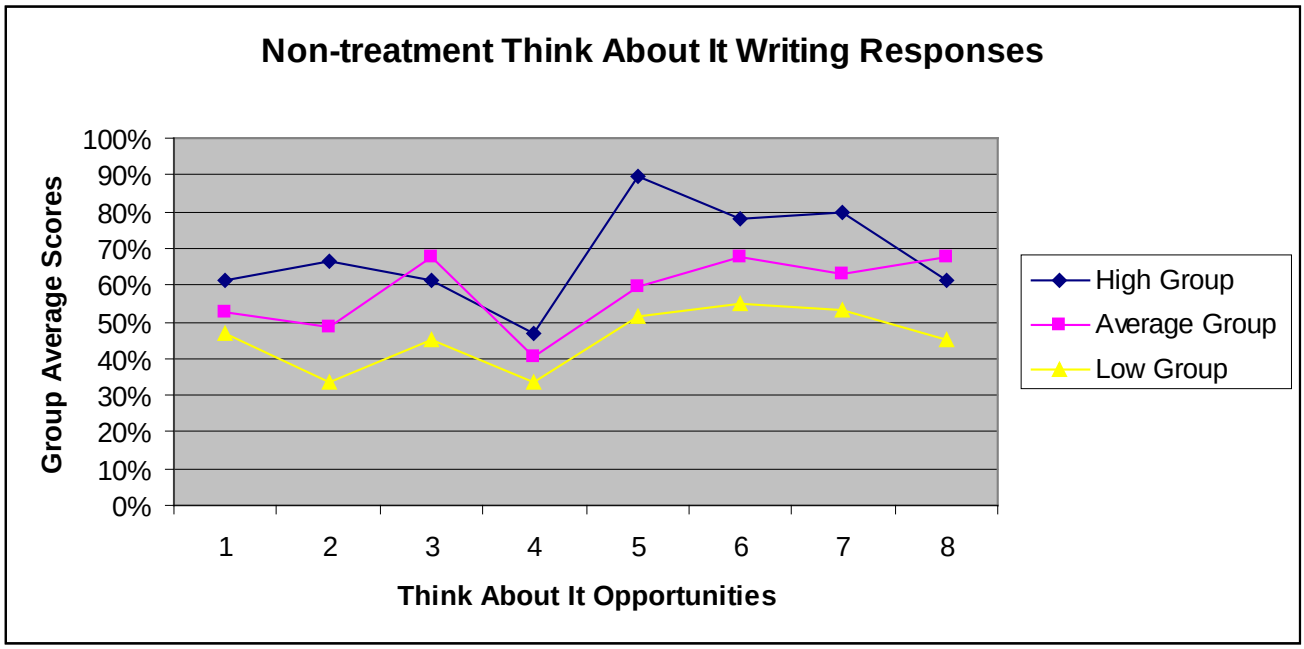

Figure 6a. Non-Treatment Think About It Writing Responses, (*N*=11 high, 7 average, 5 low).

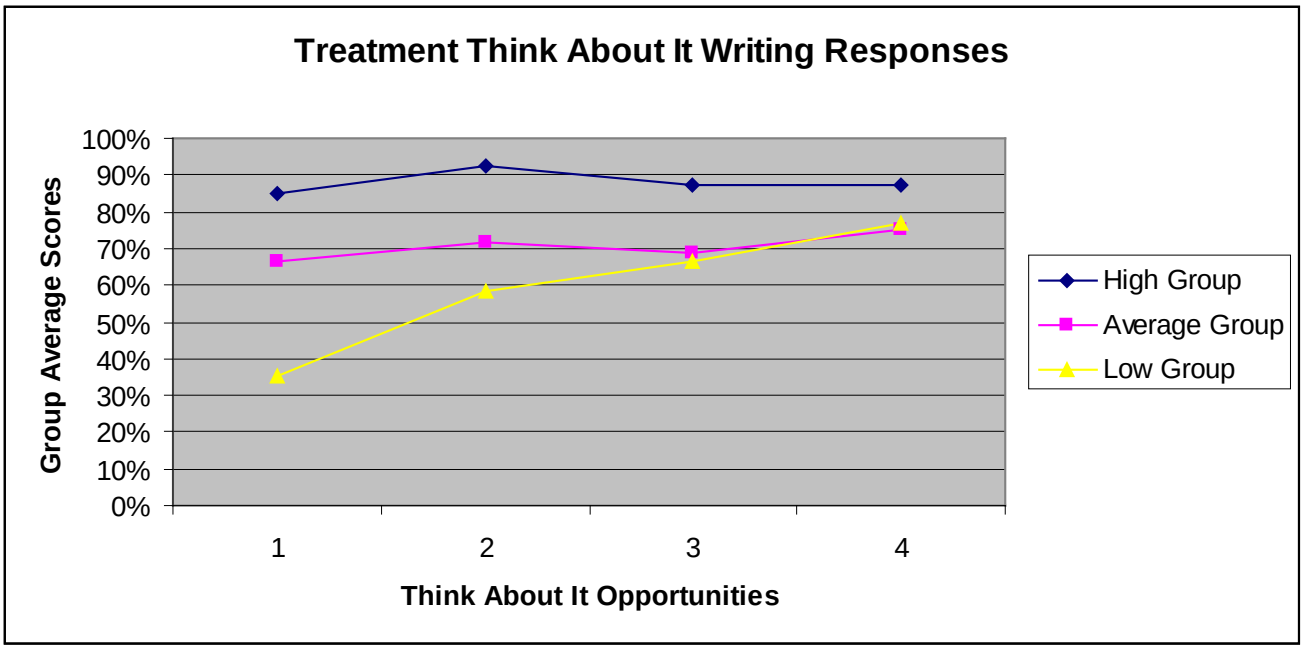

Figure 6b. Treatment Think About It Writing Responses, (*N*=11 high, 7 average, 5 low).

Yet again, we see how this writing instruction has benefited the low group the most. They started at 47% during the non-treatment units, and ended at a 77% average after the last treatment lesson. The other two groups show similar growth spurts. The high group went from 61-88%, and the average group went from 52-75%. If there were only more time…..I would like to have seen where these averages leveled out over the course of an entire year. However, that was not meant to be at this time.

The final area to analyze deeply was student attitudes towards learning science. The most helpful measurement tool for this was the attitude survey. It gave me the opportunity to track changes in attitudes as we worked through the lessons. Figure 7 helped me to see that the use of the notebooks increased students' positive perceptions about science learning.

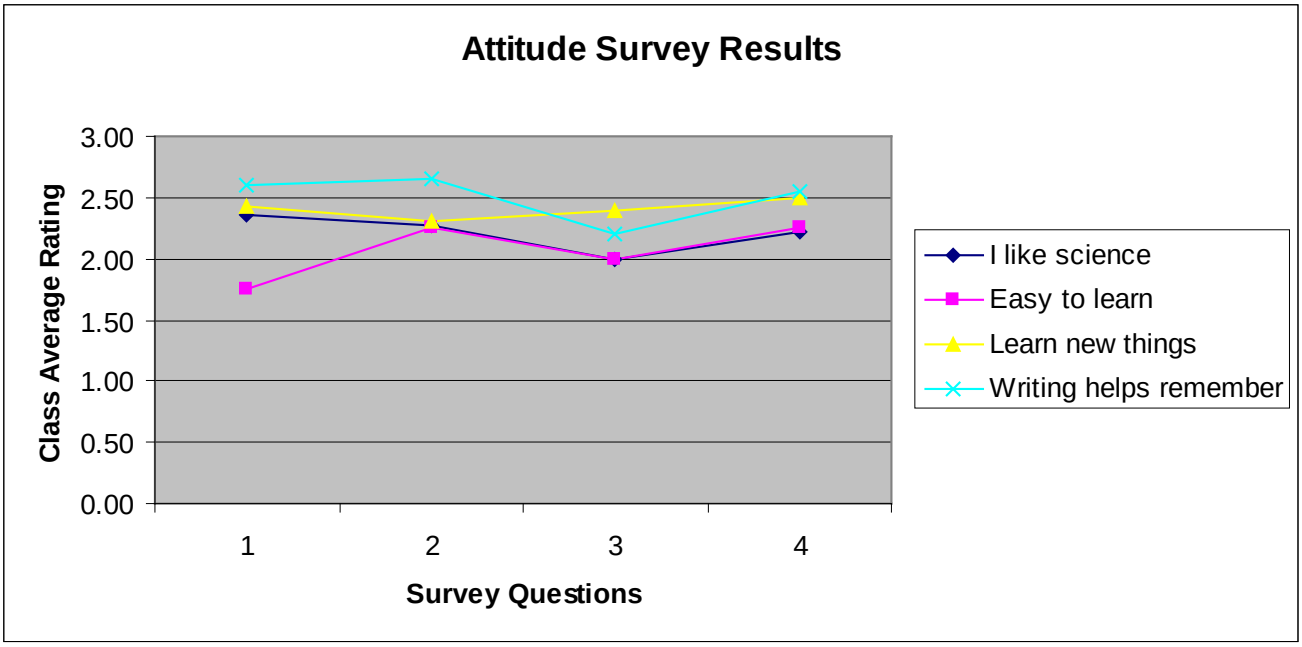

Figure 7. Attitude Survey Results (*N*=11 high, 7 average, 5 low).

The growth shown wasn't nearly as dramatic as some of the other data I've shown you, but combined with student comments, I think the general attitude about science increased slightly.

On this survey, students responded to questions by circling rarely, sometimes, or often. The main statements were:

I like learning science.

Science is easy to learn.

When we have science I learn new things.

Writing about science helps me remember what I've learned.

Then they explained their choice in a sentence or two beneath each question.

In looking through these comments, I discovered an interesting trend. At the beginning of the non treatment, many students chose rarely or sometimes when it came to their enjoyment of science. The top reason given for this was too much writing. One student

sums it up with a comment on their survey that states they only like science sometimes "Because it has a lot of writing." Although we weren't writing in our notebooks, I did have them give written responses to end of lesson questions. Many students struggled with this at the beginning. However, these same students changed that opinion as they practiced their writing skills, and received instruction on how to formulate their responses during the treatment portion of the research. Their opinions of science then changed from rarely or sometimes liking it to sometimes or often. One student's comments on his attitude surveys that illustrate this pattern were:

> 11/24/11 – Because we have to write a lot. (Rarely like science.)
>
> 4/20/12 – It's easy for me now because the experiments help me write my thinking. (Often like science.)

The large amount of writing carried true for whether or not science was easy to learn as well. In the beginning, students struggled, but by the end, they were more excited about the experiments and the writing had become a tool for learning vs. a source of frustration. It often wasn't even mentioned in their reasoning. Two students' comments on their attitude surveys illustrate this.

> 4/20/12 Doing the investigations helps me do more writing and work like the spider plant investigation it helps me with more observations. (Often science is easy for me.)
>
> 4/20/12 – It is easy because I listen to directions. And because I like writing. It is easy for me to learn often because we're writing in our notebooks. It is also easy because we make sure everyone understands. (Often science is easy for me.)

Another theme that emerged is the experiments students did. Many commented on the experiments as a reason for liking science. Those that listed specific experiments mentioned student designed experiments exclusively. Throughout the treatment, there were two opportunities for this. The first was the paper towel experiment I used for training them on how to write up an investigation. The other was the plant experiment where they got to develop their own question as well as their own plan. This excitement makes it very obvious that inquiry with kids is an important piece in their learning and enjoyment of science as a discipline.

The final question to explore was how science notebooks have impacted my teaching. As you can see from the test scores, writing competencies, and student attitudes I described above, notebooks have made a positive impact on the students. They've done the same for me. The Quick Writes and Think About It responses gave my teaching more direction. I was able to better match my instruction to student needs, and I think that resulted in better understanding all around as was reflected in their test scores (See Figure 1 and 2).

There were a few outliers in the data. The most surprising was my lower performing student group. I did not expect their test scores and writing skills to improve so dramatically. In fact, I expected them to remain low given the heavy work load of writing so much. It was a pleasant surprise to see both test scores and writing success increase during the scope of the project.

Another outlier was a student who consistently scored high and seemed to really enjoy the activities we did, but on her attitude survey stated that she didn't really like science. Her reasons were mainly topic based. One of her comments said, "It's not my

favorite because we write on the interwrite board and we don't learn about stuff that's alive."

The writing growth itself would stand alone as a reason to continue using notebooks. The pride they have in having their own science notebooks is also something that helps them to maintain a positive attitude towards science in general. An entry from my teaching journal reinforces this belief.

> You know, even if I don't see a huge difference in test scores, the value of giving kids the opportunity to have their "own" science notebook makes this so worthwhile. It also helps them to formulate questions and ideas that would not have come to my attention without the notebook experience. Our discussions are so much richer, and kids are really starting to think more deeply about the science concepts we are studying. In fact, they are often so much deeper, that I have to do research to address their ideas! I will definitely have to keep taking science courses to build up my own background knowledge (teacher journal, 1-9-12).

There was one negative factor that emerged throughout this process. The time it took to use the notebooks was frustrating. When I use them next year, I will not be quite as rigid in the format. I will definitely spend a large amount of time on the investigation write-ups, especially on claims, evidence, and conclusions. This really made my kids think deeply. As one student puts it:

> I like learning science because it helps me learn new things. Another reason is it makes me have more questions and I keep wanting them answered.

An entry from my teaching journal supports this idea as well.

> I can't believe how rich their conclusion entries were as I read through them today. I was not expecting them to be so able to express their thought processes and understandings this early. Even though this isn't an "official" notebook entry today, I can already see the conclusions section will help me to determine what understandings and misconceptions the kids have (teacher journal, 1-15-12).

After analyzing all of the rich data I collected over the course of this research, I have shown that there was improvement in student understanding. Student test scores went up, writing skills improves, and attitudes changed to a slightly more positive outlook.

INTERPRETATION AND CONCLUSION

The bulk of my research was intended to determine the impact that science notebooks would have on student science concept understanding. The data shows that the notebooks do indeed support student science concept learning. Class average test scores went up by 7% for the class in general. A sharp increase in performance was shown by my lowest achieving students who increased their test scores by 37% over the course of the project (See Figures 1 & 2).

I also wanted to find out what effect expository writing instruction would have on students' written responses and investigation write-ups. Would 2nd graders be able to understand how to write scientifically in a successful way? Through the use of the writing prompts, training in restating questions, and multiple opportunities to practice, students showed improvement and success in their scientific writing skills. At the end of the non treatment unit, students were only averaging 60% on their written responses. After initial writing instruction at the beginning of the treatment unit, that average jumped to 79% - a 19% increase. In the end, the class was averaging 82% overall.

Another issue I explored was the change in attitude towards science as a result of science notebook use. In the beginning, students felt overwhelmed by the amount of writing this involved. Many comments on their attitude surveys conveyed this frustration. Yet as they received more instruction on how to write, they began to see the notebooks as a tool for understanding and became more focused on the investigations and knowledge they were learning. As they felt more success with the writing, they recognized it as a helpful strategy in their overall comprehension of science concepts. Many even grew to like writing as a result.

The final question to be addressed was the impact science notebooks would have on my teaching. As stated earlier in the data analysis section of this paper, the biggest benefit to my teaching was the assessment opportunities the notebooks provided. In reading back through my journal entries and analyzing their written responses to end of lesson questions, I could clearly see the assessment benefits of having students keep science notebooks. The claims and evidence portions of their investigation write up opportunities were helpful as well. They helped me to see understanding as well as misconception which gave me direction for new teaching. The following excerpt from a student's plant experiment is an example of this.

Claim #1: It (sunscreen) doesn't help a plant from becoming yellow.

Evidence #1: One leaf is yellow on the whole thing except the very top. It is on the side a lot. It's also brown.

Conclusion: Sunscreen doesn't help a plant from becoming yellow. It doesn't because it soaks it up and makes it droopy. Also it makes it change color.

This particular student's writing helped me to understand that he was able to make careful observations and share some of his reasoning. He understood that the sunscreen was actually destructive instead of protective. However, I could see from his writing that he hadn't considered the plant's need of sunlight for a reason sunscreen would be harmful. Right away we were able to discuss that idea. Without this writing, I may not have stumbled across this misconception.

Writing opportunities and instruction related to the notebook are also significant teaching tools that I will maintain. It was such a joy to look back at student responses from the beginning of the research to the end and see their writing development. One of

the things I had mentioned in the introduction of this study was that time is always a factor that hinders science instruction in my classroom. The use of the notebooks has shown me that I can accomplish many of the writing goals I have for students in this setting. Next year I will be decreasing the amount of daily writing time and increasing the science minutes because this study has shown me that I can accomplish the same goals through science instruction.

So, what does all this mean for the science instruction I will use in my classroom? Because test scores improved, writing skills blossomed, attitude towards science were more favorable, and my ability to assess students became richer, the science notebook will remain a teaching technique and learning tool in my classroom in the years to come.

At the conclusion of my research, I was left with a few questions I'd like to explore in the future. One of my frustrations with the notebooks was the time it took to complete them. I felt like I taught less science topics because of being so particular about the kids writing up investigations, answering Think About It questions, and keeping their notes organized. Will I get the same results on test scores and writing skills next year when I'm not so intensely focused on data collection and analysis?

Another question that arose from this work was whether or not the science tests from the Harcourt Science 2002 series that I use were difficult enough for my students. If I develop different performance assessments would they challenge my students more?

Though I won't research these questions quite as intensely as I have done for this project, I will definitely be using this year's data to compare with student work next year. Does this research hold true for every class I teach? It will be an interesting comparison due to the fact that the class coming up has many students with challenging behaviors and

learning issues. Will this notebook technique work for a class that has a larger percentage of lower performing students?

In closure, I have a few tips for teachers who want to give science notebooks a try in lower elementary classrooms. The first tip is to model, model, and model. Lower elementary students take a long time to complete writing activities, and when you are asking them to write about their thinking in science it can be intimidating. The more modeling, and the more practice they get, the better results you'll see. Figures 6a and 6b illustrate the positive changes that came about after writing instruction began during the treatment, especially for the lower and average performing students.

Another tip is to use the vocabulary word because whenever you ask students to write in their student notebooks. I think this will happen because……. Younger elementary students have reasons for what they think, but are not always used to articulating them. The word because was a life saver for me this year. A side benefit is that they start applying that word to other writing responses in different curriculum areas, and you see the quality of their writing improve all around.

One final suggestion is to think very carefully about the type of notebook you want to use with your students. I've tried composition journals as well as binders with loose leaf paper. The journals are nice because the pages stay together. They are also small and easy for students to carry around and to store. The disadvantage is the inability to add notes for previous topics in an organized way. You'll find yourself and the students referring back to prior topics, but if the notes are in different places in the journal, it can be a trial for everyone. The binders work well in allowing that organization piece to happen. If students want to add to a topic, they can just clip the

new information in the appropriate place in their binders. However the biggest disadvantage is the holes on the pages tear out easily. It can also be a real challenge for students to clip and unclip the binder rings.

I sincerely hope that you will try notebooks with your students. They can be a lot of work, but the research I've conducted in my classroom has convinced me they are worth the effort. A 37% increase in the span of four tests for my lowest performing students is evidence enough that there is value in science notebooks in the lower elementary classroom.

VALUE

Though there aren't many studies I've found that directly relate to younger elementary students and their use of science notebooks, I have learned their value in my classroom through my own research. This experience has been the most difficult and most worthwhile endeavor I've undertaken in my professional life.

I started out in search of the impact of student science notebook use, but the experience in assessing, data analysis, and research has made me a better teacher all around. I've used the analysis techniques I've learned in my other subject areas and it has given me a much stronger picture of student strengths and needs. They are learning more in all academic areas because I chose to take on this project. I will never forget this incredible learning opportunity.

In future years, I will continue to use science notebooks. The strongest component will be the investigation write ups. The conceptual understanding I can view based on student responses in the claims and evidence portion of these write ups is invaluable. While it may take more time than I would like some days, it is well worth the effort in the sense that it informs my teaching and solidifies concepts for students. I can't glean that kind of information from multiple choice tests.

I will also continue to use Think About It written responses. This information helps me to quickly assess student understanding on a lesson by lesson basis. This also serves as a helpful tool to the students who can keep these in their notebooks for reference.

In addition to the student notebooks, I've become an even more avid supporter of teaching science through inquiry. The kids come alive and do deep thinking about science

concepts when they are in the midst of doing their own research. Their survey responses, and interview answers reflect that excitement. This project has allowed me to feel some of what they feel as they discover new ideas through their questions and experiments. The pride and excitement that shines on their faces as they do science inquiry is priceless. I very much wish I had been afforded the opportunity to learn science this way when I was a younger student. I can see how much it inspires my students today, and I sincerely hope it will continue throughout their educational years.

In conclusion, the value of this project has been three fold; I have become a more effective teacher, students better understand science concepts, and student writing skills have vastly improved. What can be of more value than that?

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APPENDICES

APPENDIX A

ATTITUDE SURVEYS

Attitude Survey for Non-Treatment Cycles

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Name_____

Date_____

Directions: Read each sentence. Circle the face that tells how you feel about each sentence. Write your reasons for your responses.


Rarely


Sometimes


Often

1. I like learning science.



Give reasons for your answer:

2. Science is easy for me to learn.

  

Give reasons for your answer, and tell why it might be easy for you to learn:

3. When we have science I learn new things.

  

If you chose sometimes or often, please share an example of something new you have learned this year.

4. Writing about science helps me remember what I've learned.

  

5. What is it about science that would help you learn a lot?

Attitude Survey for Treatment Cycles

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Name_____

Date_____

Directions: Read each sentence. Circle the face that tells how you feel about each sentence. Write your reasons for your responses.

 Rarely  Sometimes  Often

1. I like learning science.

  

Give reasons for your answer:

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Give reasons for your answer, and tell why it might be easy for you to learn:

3. When we have science I learn new things.

If you chose sometimes or often, please share an example of something new you have learned this year.

4. Writing about science helps me remember what I've learned.

5. What is it about science that would help you learn a lot?

6. Using a science notebook helps me understand science.

Give reasons for your choice:

7. Have you ever used a notebook before?

8. Circle any parts of the notebook that help you learn best. Put a “1” by the most important item.

Contents
Notes
Investigation Write-ups
    Question
    Prediction
    Plan
    Observations (Data, Charts, Graphs, Drawings, illustrations)
    Claims and Evidence
    Conclusion
    Reflection
Writing Prompts
Glossary

9. Circle any parts of the notebook that help you learn the least:

Contents
Notes
Investigation Write-ups
    Question
    Prediction
    Plan
    Observations (Data, Charts, Graphs, Drawings, illustrations)
    Claims and Evidence
    Conclusion
    Reflection
Writing Prompts
Glossary

10. When we have writing lessons, it helps me write my notebook entries better.

11. I like using a Science notebook.

Give reasons for your answer.

APPENDIX B

WRITING RUBRIC

Writing Response Rubric

This Rubric will be used to evaluate the quality of written responses to science lesson assessment questions.

4

- Student answers question completely.
- The writing is very well organized.
- The writing helps me to understand the student's reasoning very well.
- Student uses helpful examples to support their ideas.
- Student uses appropriate scientific vocabulary in the response.
- Student uses detailed diagrams, drawings, charts, etc. when appropriate.

3

- Student answers question adequately.
- The writing is adequately organized.
- The writing helps me to understand the student's reasoning adequately.
- Student may or may not use examples that are helpful in supporting their ideas.
- Student uses appropriate vocabulary, but it may not contain scientific words pertaining to the topic.
- Student attempts to use diagrams, drawings, charts, etc. when appropriate, but may not be highly detailed.

2

- Student attempts, but does not fully answer the question.
- The writing is not well organized.
- The writing does not help me to understand the student's reasoning very well.
- Student does not use examples that are helpful in supporting their ideas.
- Student does not use scientific vocabulary, and may use vocabulary that does not pertain to the topic.
- Student does not use diagrams, drawings, charts, etc., or if they are used, they do not support the student's reasoning.

1

- Student provides an incorrect response.
- The writing is not organized and is hard to follow.
- The writing shows a lack of understanding about the concept.
- Student uses no examples to support their ideas.
- Student does not use vocabulary appropriately, and no scientific vocabulary is used.
- Student does not use diagrams, drawings, charts, etc.

0

- Student does not answer question at all.

APPENDIX C

INTERVIEW QUESTIONS

Interview Questions for Treatment

1. How did you feel about science in 1st grade? What were some things you liked about it? What are some things you didn't like?

2. How do you feel about science this year? What are some things you like about it? What are some things you don't like about it? Give me reasons for each thing.

3. What helps you to learn science the best? Experiments? Reading in the text book? Writing about what you've learned? Explain your reasons.

4. How well do you feel you understand the ideas we're learning in science this year? What would help you understand better?

5. Do you like writing answers to the Think About It questions after each lesson? Do you think writing helps you remember what you've learned? Does it help you learn the science ideas better?

6. Let's talk about the science notebook for awhile. Do you enjoy using the notebook? Can you explain why?

7. How often do you look back in your notebook to reread things you've written? Does it help you to remember your ideas? Do you think after you've written in your notebook it helps you to answer test questions better?

8. How useful is the Table of Contents? Do you ever use it to help you find a specific investigation in your notebook?

9. When you write up your investigations, which components help you understand or remember what's happening the best? (Question, Prediction, Plan, Observations, Claims and Evidence, Conclusion, Reflection)

10. How often do you use your glossary? Do you ever use it to help you when you write your answers to the Think About It questions? Do you use it to help you remember what words mean? How to spell them?

11. Do you have anything else you would like to tell me about your experiences with science? This year? In the past?

APPENDIX D

SUMMATIVE ASSESSMENTS

Chapter Test Example

(Jones, Robert M., McLeod, Krockover, Frank, Lang, Valenta, & Van Deman (2002).

Name _____

Write the letter of the best choice.

9. The way an animal looks to help it hide is called ___.
   A hibernation B camouflage C habitat

10. An armadillo's hard plates are an ___.
   A adaptation B environment C estivation

11. Many animals ___ to warmer places to find food.
   A hibernate B estivate C migrate

12. Some animals ___, or go through winter in a deep sleep.
   A migrate B estivate C hibernate

13. Some animals ___, or stay in a deep sleep in the summer.
   A migrate B estivate C hibernate

Part II *Science Concepts and Understanding*

Circle the letter next to the word that names each animal's habitat.

14. 
   A desert C rain forest
   B pond D tundra

15. 
   F ocean H forest
   G desert J rain forest

Name _____

16. 

F rain forest H ocean

G tundra J forest

Complete the chart. Write *F, S,* or *FO* in each blank.

F = freshwater habitat
S = saltwater habitat
FO = forest habitat

ANIMAL HABITATS

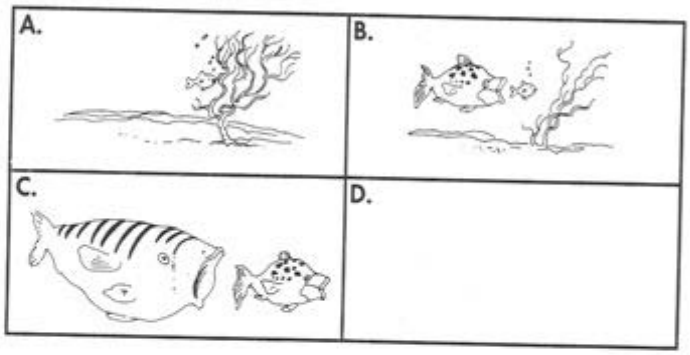
17.			___
18.			___
19.			___

Name _____

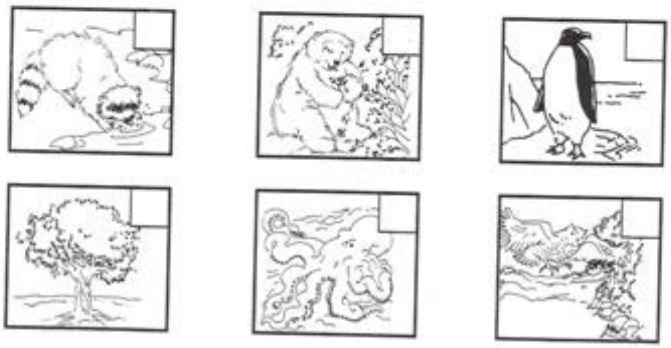
Part III Process Skills Application

Process skills: communicate, classify

20. Draw what could happen to the fish with the stripes.



21. Write an *F* beside each thing that belongs in a forest habitat.



Name _____ Date _____

PERFORMANCE TASK

A Food Chain

Materials


crayons


construction paper


string

1. Work with a partner. Choose a habitat from the list in the box.

rain forest	pond	forest
salt water	Arctic	

2. Think of an animal that lives there.
3. List some things your animal might eat.
4. List animals that might eat your animal.
5. Draw your animal, the things it might eat, and the animals that might eat it.
6. Cut out your pictures. Tape them in order to a piece of string to make a food chain. Explain your animal's food chain to classmates in a small group.

APPENDIX E

FORMATIVE ASSESSMENTS

Teacher Journal Guiding Questions

What is the impact of science notebooks on students' science concept understanding?

What components of the notebook are most helpful to student understanding?

How will the use of science notebooks impact my teaching?

What impact will expository science writing instruction have on student notebook entries?

How do science notebooks affect student attitudes about science?

Other comments:

After each lesson, I will use these questions to make specific entries about my thoughts about the successes and failures of the lesson. When the non-treatment and treatment is concluded, I will look for patterns in my responses that will contribute to my understanding of how science notebooks impact student science understanding, my teaching, and their attitudes about science.

Quick Write

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Name_____

Date_____

During the next five minutes, write down everything you can think of that you've learned about _____ .

(student writes in concept currently studying)

APPENDIX F

IRB APPROVAL

MONTANA
STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

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MEMORANDUM

TO: Kimberly Devore

FROM: Mark Quinn, Ph.D. Chair Mark Quinn CTJ
Institutional Review Board for the Protection of Human Subjects

DATE: December 5, 2011

SUBJECT: *Science Notebooks in the Lower Elementary Classroom* [KD120511-EX]

The above research, described in your submission of December 5, 2011, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal Regulations, Part 46, section 101. The specific paragraph which applies to your research is:

X (b)(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

X (b)(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

___ (b)(3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

___ (b)(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

___ (b)(5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

___ (b)(6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX G

INVESTIGATION WRITE UP TEMPLATE

INVESTIGATION:_____

DATE:_____

QUESTION:_____

_____

_____

PREDICTION:

I think _____

_____

_____ **because** _____

_____

_____

_____.

PLAN:

1. _____

   _____.

2. _____

   _____.

3. _____

   _____.

4. _____

   _____.

5. _____

   _____.

6. _____

   _____.

7. _____.

OBSERVATIONS:

CLAIMS AND EVIDENCE:

Claim #1: _____

_____.

Evidence #1: _____

_____

_____

_____.

Claim #2: _____

_____.

Evidence #2: _____

_____

_____

_____.

Claim #3: _____

_____.

Evidence #3: _____

_____

_____

_____.

CONCLUSION: _____

REFLECTION: _____