

THE EFFECTS OF THE 5E INQUIRY TEACHING COMPARED TO TRADITIONAL
TEACHING IN A SIXTH GRADE SCIENCE CLASS

by

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ABSTRACT

Inquiry has been proven to be a successful way of teaching to get students to be interested in science. This study looked at the 5E inquiry compared to traditional teaching to see if students would be more interested in science. Through interviews, tests, journals, surveys, and observations, the conclusion is that students perform better, as well as increase their interest in science, when taught with inquiry.

INTRODUCTION AND BACKGROUND

During my seven years of teaching, I noticed that one of the major problems in students is a lack of interest in science. I wanted to find out how I could use the “5E inquiry method” of teaching to pique students’ interest in science. Another issue I noticed is that students often chose the method which lends itself to less work, and didn't embrace being challenged in science, as well as in any subject. I examined the impacts that the inquiry method has, not only on the students’ motivation and attitude towards science, but also on me as a teacher.

As a teacher, I felt I needed to prepare these students for the real world. Students needed to examine the concepts to solve problems instead of being told exactly how to do things. I noticed how students chose the easier alternative rather than the more challenging one; however if they were being challenged through problem solving, the students became more involved in science. Students were in control of their own learning and need to take more ownership of it. When students were constructing concepts rather than being lectured, I observed that they learn more. I determined that students do learn better when being questioned instead of being lectured.

There are many different ways to learn, but the inquiry method includes all the different methodologies of teaching in one instructional technique. It gains the attention of all learners, challenging the higher and lower achieving students (Darling-Hammond, 2008). I wanted my sixth grade students, who attend a rural school, to be able to think at a higher level and the inquiry method is one that allows students to think for themselves and figure things out. Inquiry can be used in every area academically, therefore helping

all teachers see what a great significance using the inquiry method would be in their teaching. Because I had a small class this year, I felt this could be significant because I got to know my students on a deeper level than other teachers who have more students.

An inquiry lesson in my class went through the 5E model of inquiry using the processes of engaging, exploring, explaining, evaluating and extending. The students were engaged right from the beginning, explored on their own, while asking questions and got the class to go to the next level. The students learned that it is important not only to question, but to record everything that is observed or done in the experiment.

My primary question for this project was: How can I use the “5E inquiry method” of teaching to pique students’ interest in science? The secondary questions for my research were: 1) What were the effects of inquiry on students’ problem solving skills? 2) How will inquiry teaching affect me as a teacher? 3) How does inquiry teaching affect student engagement and attitudes towards science?

CONCEPTUAL FRAMEWORK

The articles all had a common theme that inquiry motivates students as well as improve their learning through the inquiry approach. There has been multiple research papers written on this topic, as well as studies through the National Science Teacher Association (NSTA), proving that inquiry creates a love for science and helps students to become better problem solvers (National Science Teachers Association. 2002, Marx, 2004, Scruggs and Mastropieri, 1993, Towns and Sweetland, 2008). In my research, I found that students enjoy science more through experiments, as evident in my data from the interviews.

Science is pivotal for situations in the real world and it is important to have students learn about science through experiences (Spencer, 2012). One of the major points in this article was that the NSTA found that the inquiry method is helpful in engaging students to want to learn more in science, resulting in being able to use this model in other curricula (Spencer, 2012). It is important to use inquiry in all subject areas because it helps students to problem solve and think on their own. Because I believe students need to problem solve more often, I wanted to utilize the inquiry method in other subjects to challenge students in all areas of school.

There were several different instructional ideas that pertained to my area of research, which models the 5E inquiry method. One article showed an example of the 5E model which helped focus students and guide them to understand the concepts being taught. There were different types of information provided to help the teacher figure out how to engage the students, how to provide information for the students, how to ask questions and get the students to go to the next level, and how to have the students present their findings (Spencer, 2012).

In the way our world is heading, critical thinking is an important aspect to understand. Through the inquiry process, critical thinking is the main component in figuring out concepts that are being taught. Students have to generate questions, test their hypothesis about the questions, observe, find any problems in the experiment, continue testing and then ask more questions to take the idea to the next level of thinking. The National Science Teachers Association has stated that “the use of scientific inquiry will help ensure that students develop a deep understanding of science and scientific inquiry”

(NSTA, 2002, paragraph 4). One of the articles showed different stages that were implemented and details were given as to how to go about using the inquiry method while teaching (Spencer and Walker, 2012). This style of teaching helps students to connect science to their everyday life as well as having a deeper understanding of the concepts that are being taught (Spencer and Walker 2012).

Inquiry based teaching was the basis of my project because I felt it would help motivate students to want to work harder in school. Different cooperative learning techniques and real studies with schools showed that students improve in their learning through these methods (Darling-Hammond, Barron, Pearson, Schoenfeld, Stage, Zimmerman, Cervetti, and Tilson, 2008). In all of the studies, the biggest hurdle was the time it takes to implement these different teaching techniques and to make sure everyone is on board with these ideas. In one of the experimental studies, it showed that when sixth graders are presented with challenging problems after using the inquiry method, they are more likely to attempt to figure out the problems instead of giving up (Spencer and Walker, 2012). Students critical thinking techniques are used more when the inquiry method is used.

The job market is changing, therefore as teachers, we need to modify how we are teaching so students will be successful or prepared throughout the rest of their lives (Baring and Dalring-Hammond, 2008). This isn't to say that all students will have these types of jobs, but if they are more prepared with challenging activities and knowing how to solve problems, this will help the students in the long run to achieve more throughout their schooling. The workforce is changing and employers are expecting their employees

to figure out what to do, not be told what to do. Inquiry helped students to be able to figure out how to accomplish tasks on their own instead of always needing someone to help them out.

Multiple studies were conducted and it was determined that even students who were struggling showed significant improvement in their academic progress. A study done in Michigan, with 8,000 middle school students, using the inquiry method over a three year period, showed that in 17 of the 18 categories taught, students made improvement in their understanding of the science content (Marx, 2004). One of the important aspects of inquiry was getting students to understand what was being taught, which was shown through the study in Michigan. In any study, there were outliers, but the overall data proved that students understand the content better when being taught through inquiry teaching compared to a traditional type of teaching like using a textbook or lecturing. Inquiry continues even after the project and it helps students understand the content better.

Although I focused on inquiry in science, this method of teaching could be utilized in every subject. Looking at different subjects showed how the inquiry method could motivate students to achieve more academically, and pull those struggling students to a higher level of thinking. The results shown gave an overview of how the inquiry method has affected multiple classrooms all over the United States (Towns and Sweetland, 2008). Another study researched 26 junior high school special education students who were taught using the traditional textbook method and the inquiry method. The students were then tested to see the progress of each lesson. The students were also

asked which style of teaching they thought helped motivate them the most, with 80% reporting that they felt inquiry based teaching motivates them more in school (Scruggs and Mastropieri, 1993). Inquiry is a positive method used in classrooms, which has been proven over and over again. There are different processes in how inquiry works, but overall, the 5E method has proved to be an organized method, especially when carrying out the research project. The inquiry method allows students to question not only themselves, but others as well, so that they can be problem solvers. Throughout the process of inquiry, students become more motivated academically and yearn for more science.

METHODOLOGY

Treatment

Because my class was small and I taught every subject to my students, I used my whole class for interviews. In my class I had thirteen students, six boys and seven girls. No students were on IEP's, but several would need extra help during different lessons. I asked all of my students the same questions so the data would be valid and useful to me in my research project. The school is located in Philipsburg, Montana, which is a small tourist town therefore, the school has a fair amount of transient students as well, which affected the class and individual students. The overall free and reduced lunch in our school is around 50 %, which could have affected students' academic performance. The class had been taught science every year from Scott Foresman textbooks, but some teachers add their own ideas or experiments. Unfortunately, this class has lacked motivation and wants to be told exactly what to do. About half of the students want good

grades, but the other half don't care, which is evident in grades. I wanted to find out how inquiry compares to traditional style of teaching through asking a series of questions to my students. A sub-question that was answered through interviews was how problem solving will help students understand science concepts. Several of the questions asked students how they felt when they were challenged as well as if they felt they learned better with experiments which addressed the research questions. This took place during recess or during other times where there were no interruptions while I was interviewing individual students.

The treatment I used was implementing the inquiry method into my teaching of science. Because this was something that I already did, I polished up on the ways I incorporate this method of teaching. Inquiry method challenges students to construct their own meaning from the explorations and determine the science concepts. I wanted to compare the traditional way of teaching, so I countered a unit with the inquiry method, to see how students responded. I taught one chapter using the inquiry, followed by teaching another chapter in a more traditional way. After I taught these chapters, I gave students a test to look at their improvement, and how they understood the concepts that they were tested on. The three chapters taught with inquiry were "Human Body Systems", "Rocks and Minerals", and "Climate and Weather" The two chapters taught using the traditional method were "Plate Tectonics" and "Reshaping Earth's Surface". I wanted to teach more units for the project, but unfortunately school interruptions interfered with the time frame of this study. There are several different inquiry methods, but I used the 5E model, which included engaging the student, having the students explore, students explain what is

happening with the concepts, elaborate and take the experiment to a new level, and finally the students are evaluated (Bybee, R. W., Taylor, J.A., Gardner, A, Scooter, P.A., Powell, J.C., Westbrook, A., Landes, N. 2006).

The 5E method is user-friendly and was one I used in my class, so it was easy to implement into my action research project. To get the students engaged, discrepant events were a great way to have students thinking and ready to learn. Discrepant events are experiments to show concepts in a way that makes students think because they are events that “shouldn’t” happen but do. This got the students ready to explore and find out more information about the concepts we were discussing in class. After the students explored, they then explained what was going on in the experiment. At this point, the students were able to be evaluated on what they knew, and then could elaborate their ideas by finding more information on the concepts that were being taught.

I used one unit from each of the three sections of science; Life Science, Earth Science, Physical Science. One unit was taught using inquiry and the next unit following was the traditional way of teaching. In each of these inquiry units, I had the students ask questions about the subject, guided them to an experiment, and had the class experiment on their own. In some instances, the class needed to know some background information, but then they explored to learn more about the subject to gain a better understanding of the concepts. At the beginning of the year, I asked the students which science concepts they had been taught in the past, so I could get a grasp on which chapters I should teach in order to benefit the data collection in this research project. Instead of telling the students what to do, the experiments included a discrepant event or an introduction to an

experiment to engage the students to learn more about the subject. The units that came after these chapters were taught using traditional methods of lecturing and reading out of the science book. The students would take notes and we would discuss what we read, but did not go through experiments on their own. They were encouraged to ask questions, but most just took notes while we read or discussed through the traditional type of teaching.

Through each unit taught with inquiry, the students were first engaged, then they explored the concept, explained what was going on, then elaborated on the concept and the final step was an evaluation to make sure they understood the concept. In the traditional form of teaching, I used the text book and lectured more frequently to see if that would help students understand and enjoy science more.

The first inquiry unit was the human body chapter, which had five lessons, and took three to four days per lesson depending on the depth and how much the kids explored and asked questions. Some units could go longer than others because I wanted the students to be able to not have a strict time limit on learning, but still be able to have a closure to move onto a different lesson. Unfortunately I couldn't control the interruptions during science, so that is another reason some of the lessons took longer than others.

All science can be taught through inquiry, but an interesting lesson was the human body. To get the students engaged and thinking about what they knew, I had the class brainstorm the levels of organization in the human body. Because a majority of the students had been taught science throughout all of their elementary time, they knew the levels of organization from cells to tissues to organs to body systems. With the next

lesson being muscles and bones, I had the class look closely at these two important systems. To engage the class, I gave them a piece of fried chicken to dissect and look closely at muscles and bones. The class broke the bones to inspect what was inside of the bones as well. Even though it wasn't our muscle and bones; the class got a closer look at how these two systems work together. One activity done was to put craft sticks on the students' fingers to show what it would be like without muscles in their fingers. The students had trouble writing in their journal and it was quite entertaining watching them try. In this lesson, students learned not only how their muscle and bones work, but also an inside look at an animal's bones and muscle.

Respiratory and circulatory systems were engaged through the students participating in different aerobic activities. I had the students take their pulse at different moments to show how the circulatory and respiratory system work together to help the body transport blood and oxygen. The students recorded their pulse in their journal, first at resting, then after one minute of running in place, then resting a minute, then lying down with their eyes closed. Some students had a harder time finding their pulse, but as a class we discussed the results together, so we could see the trend of pulses from each activity. After comparing the results, the students worked through an image of a heart to go through the flow of blood, as well as the types of blood that go through the heart. I guided the students to show how to do this and the students were on their own to finish the picture of the heart. Students also had to label the lungs and the respiratory system with guidance. I observed that this group of students wanted to be told exactly what to do instead of trying to figure it out with some guidance. Through this process, I continued to

ask questions to help guide the students instead of telling them exactly what to do.

Although it is hard to do, I know in the long run the students will benefit from figuring out problems over me telling them exactly what to do.

After all of the five lessons were taught and explored, the students took a test on the human body. The test was a mixture of multiple choice, short answers, and labeling the different systems. Before a test was given, I reviewed the unit with the class and they received a study guide to help them with the test.

The non-treatment lessons did not take as long because there wasn't exploring or questioning involved. The class would read from the book and discuss what was read, then move on to the next lesson. In some instances, I had the class present what they read with posters or other items to keep them engaged as much as possible without doing inquiry. The non-treatment units were only three days because the students were just reading or listening to the lessons, not exploring to find out more information. The information was given to them first, instead of exploring about the subjects first like the inquiry method. Even though it takes more work as a teacher to teach with inquiry, it is worth it to see a light bulb go off with students as they are learning.

Instrumentation

Table 1 shows how I collected the data to answer my research questions that I am asking myself. In the surveys I used numerical data to look at their answers and in the interviews I looked at observational data. I looked at improvement in scores from the science journals and tests to see if students understood the science concepts better.

Table 1
Research Matrix

Data Table				
Research Questions	Surveys	Test Scores	Interviews	Science Journals
How will the inquiry method increase student interest in science as well as improve their understanding in science concepts?	Numerical data.	Improvement in scores.	Anecdotal and observational data.	Improvement in rubric scores.
How does the inquiry method versus traditional method affect science achievement?	Numerical data.	Improvement in scores.	Anecdotal and observational data.	Improvement in rubric scores.
Which method- inquiry or traditional- will improve students test scores?	Numerical data.	Improvement in scores.	Anecdotal and observational data.	Improvement in rubric scores.
What are the effects of inquiry on students' problem solving skills?	Numerical data.	Improvement in test scores.	Anecdotal and observational data.	Improvement in rubric scores.
How will inquiry impact me as the teacher?	Numerical data.	Improvement in test scores.	Anecdotal and observational data.	Improvement in rubric scores.

In order to find out if inquiry piqued students' interest in science concepts, I observed the students and took anecdotal notes in a teacher journal. I interviewed the students before and after treatment and compiled results of their responses. I administered tests and collected student work samples to demonstrate what the students did to compare the two styles of teaching. The tests given were a mix of teacher made assessments and the curriculum assessments. I developed a ten question interest survey which I gave three times during the year. To make this a simple survey, I had the students circle always, sometimes, or never with the questions. The students took this survey and

I analyzed it to see if the students' interest in science was raised after teaching the units. I used the survey as well because some students are better at writing down their thoughts than recording them in an interview. The science journals were looked at after each unit by me and they also self reflected on their journals using a rubric. These were used to see how the students understood the content being taught.

Interviewing students helped to get feedback individually about how the students perceived what was truly going on in the classroom. By utilizing an I-Pad, I analyzed the data by listening to the interviews and writing down what the students said. This form of data collection puts the thinking back on the students and helped me, as the teacher; look at what the students were processing in the classroom. Interviews assisted me in determining students' views and opinions about the scientific process. Using interviews as an instrument for my action research helped in looking at inquiry compared to the traditional type of teaching by examining the thought process of students (APPENDIX A).

Another instrument that I used for my action research project was the students' science journals. I used a rubric to assess the effort and thinking skills of the students' scientific processes. Because the students science journal was a tool that they used Individually, this was a great instrument to see if the students understood what was being asked of them or not. By showing them the rubric ahead of time, the expectation was that they would perform at a higher level of learning. I wanted my students to record in their science journals as much as possible. Having a rubric got the students to put forth the effort needed to show that the inquiry method helped students understand science

concepts in a more in-depth way (APPENDIX B).

These data collection methods provided a mix of perspectives because the interview focused on asking the students their thoughts while the science journals looked at student work. Both of these instruments helped me observe the students in how they were performing in science class. It was important to get feedback from the students, but to also look at students work. The students could be saying one thing, but to look at the work they were producing helped in my research to see what the class learned.

To make sure the answers were reliable, it was important to have only the teacher and the interviewee present while I asked questions. At the beginning of the year, I interviewed each of the students about how they learned best as well as their opinions towards how science is taught. I reassessed the class in the middle and the end of the year to see how each individual student was gaining in their science knowledge.

A method for me that provided interesting data was interviewing the students. I asked the students a series of eleven questions during recess time. I included all of my students because of the small class size that I taught. The questions ranged from how students learn best to how they feel when I ask questions and don't give them an answer. Throughout the interview, I used probes to get the students to answer more in- depth with the questions. I-Pads were used to record the students to make it easier to analyze the answers and to insure that my data was valid. Students did not know the questions being asked which made the data more reliable. Even with the students not knowing the questions, some of the answers seemed like they just told me what they thought I wanted to hear.

The interview process allowed students to think outside the box individually without looking to their friends to answer the questions. My sample included seven girls and six boys in my sixth grade class. I was the only sixth grade teacher and taught all subjects, so throughout this process I used all of my students. The interviews were performed over several lunch periods and before school to make sure that the interviews weren't interrupted and the data would be valid. Only one student was interviewed at a time, so the students would answer for themselves, not what a friend would say. The interviews proved to be enlightening and helped me in analyzing data for my project.

The questions asked during the interview addressed students learning styles, their thoughts on science and how they felt when being challenged in school. These assisted me in looking at how students felt about learning and their thought process while figuring experiments and/or problems out. With interviews, the students had to use a higher level thinking to answer questions that were sometimes not asked of them. I was hoping this would open doors for the students to ask more questions of themselves while they were in class to challenge their thinking. I have observed students wanting the answer given to them instead of trying to figure the problem out on their own. The inquiry method of teaching got kids to experience science on their own and find the answers instead of just being told what to do.

The interviews were recorded on the I-Pad, so after I did the interviews I listened and watched them to analyze what was said. With each question, I put the answers from all the students on a piece of paper and grouped the similar answers together. After listening to the answers and grouping them together, I put the questions in a chart. In

order to organize the data, a chart showed the answers in a clear and concise manner. In order to group the questions with similarities, I organized the answers into similar categories. The categories for the answers were: 1) how the students learn, 2) how the students understand the material, and 3) their motivation. Each time there was an interview, the answers were added to the chart to see if they have stayed the same or changed depending on what science unit was taught and how it was taught. Overall, the answers will show whether the students understood the concepts being taught through inquiry and traditional type of teaching.

Science journals were a major part of my class. I felt journals would be a great instrument to see if students understood the concepts being taught. To make sure that this was a valid instrument, I used a rubric created from Rubistar to grade the science journals (APPENDIX B). I had two colleagues score the journals to look at similar scores and keep the scoring valid. Through the science journals, I was able to look at how the students understood the science concepts taught by using the inquiry method and the traditional method of teaching. Again, I used the only class I taught which was thirteen students, six boys and seven girls. The students had a rubric to help guide them to a higher level of learning. These were graded once a week to collect as much data as possible (APPENDIX C). The other growth I wanted to see through the science journals is that students would be challenged more throughout science and be able to ask more questions by themselves instead of me just telling them the answer.

The rubric had five different categories based on content, participation, understanding concepts, and the overall idea of what was taught. With science journals, I

wanted to measure the students' content knowledge over minor errors in their writing. In the students' science journal, it was important for them to be organized with dates and correct content so I could check to make sure they were understanding what was being taught. Through the rubric, I was able to analyze whether the students put more effort into their journals while being taught the inquiry method compared to the traditional method of teaching. This showed each students understanding of the science concepts being taught (APPENDIX D).

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (APPENDIX H).

DATA AND ANALYSIS

The data collected through this project showed that inquiry teaching helped motivate students to want to learn more about science. I used different tools to examine the data I collected. Through this process I interviewed students, had the class take a survey, looked at test scores, examined science journals and looked at my own observations from my class. Each of these tools provided useful information that proved inquiry teaching improves student's outlook on science concepts.

Overall, most of the students said that experiments helped them learn because it got them to "think" and it was "a fun way to learn." The majority of the students said they could ask the teacher when they didn't understand a concept, which was a positive idea knowing that I could help them to understand what is being taught. The students did not know what the inquiry method was, but I utilized it daily, I just didn't say "inquiry

method”. That was eye opening and made me realize I needed to mention the word inquiry more frequently when I was teaching.

When the students were asked how they learn best, most of them answered that they learn best by the teacher explaining the concepts to them and they are most likely to ask the teacher if they don’t understand an idea being taught. A couple of the students did mention that they learn best when they figured out problems on their own. Some of the students that said they figured out problems on their own were ones who constantly needed redirection, from my observations. I noticed that throughout the year, sixth graders wanted to be independent and follow what their friends did, but in turn they don’t try. I also think it comes from a deeper issue with home life and parents doing everything for their children. In questions about how students learn and motivation, the conclusion was that students do need their teachers to guide them in the classroom. Inquiry could be teacher guided, while trying to get students to be more independent. As a teacher, I needed to guide the students without telling them exactly what to do. This type of teaching is not just students’ doing everything on their own, it is teacher guided, but students figured out the problems on their own.

Through the different lessons taught, some students didn’t need the teacher through inquiry, but other times those same students did. If students had previous knowledge in the unit being taught, then the higher achievers were more likely to be engaged in the inquiry method. Through my observations I hoped the students would try harder, but very little tried. They wanted me to tell them exactly what to do. I have taught other classes that were more willing to try than this class. They had a hard time

doing anything on their own, especially second semester. Some of the students' seemed to give up instead of problem solving.

Being challenged and thinking is one way the students felt that me asking them questions helped with understanding concepts being taught. I wanted the students to be able to think for themselves. Listening to their answers helped me to analyze that students want to be challenged, even if they don't like to be. Some students got frustrated when I didn't give them a direct answer. The students' response was that when I asked questions it helped them to think more and figure out the problems. One student stated, "I like when you ask questions, gets us thinking may not get the right answer but still gets us thinking." Another student mentioned, "when you ask us questions it makes you think and when you just give us the answer we don't think about it." Overall, the students wanted to be challenged to a point, but still needed that guidance to help show the concepts that were taught.

During the second interview, which was four months after the first interview, the students were more aware of the questions and seemed to put more effort into the answers. I also told the students to really think about the questions because it was helping me in my research. It was interesting to compare the interviews and see how much more confident the students were in their answers. Throughout this process, I saw my class grow in their ability to take ownership for their learning and be aware of how they are learning. The consistent use of terminology and vocabulary helped the students to understand what was being asked of them throughout the year.

With the first interview, more students answered that reading from the book was

how they learned best but during the second interview all but one student said they learned best through experiments. I focused more on comparing inquiry and traditional teaching after the first interview so the students noticed that they learned better through hands-on learning. I emphasized on how they were learning so they were more aware of how they learned the concepts.

As a teacher, I tried not to emphasize how students were learning because they needed to figure it out on their own. Through this research project, students recognized the best way for them to learn compared to what they thought was the best. This was informative to me because of the amount of students at the beginning that said traditional teaching helped them learn better, but by the end of my study, those students were saying they learned better by experiments and being engaged. Until students are truly engaged in experiments, they believe the easy way out is the best way to learn. It may be the easiest, but they aren't learning or retaining as much information.

Some of the students said "I don't pay attention when we are reading out of the book", compared to the first interview when they said "reading out of the book helps me learn". When the units were being taught with more emphasis on traditional or inquiry, the students saw how they truly learned instead of just thinking how they learned best. Although the students seemed more confident during the second interview, a couple of the students still seemed nervous. The answers to some questions may not reflect correctly because some students may not have heard the questions correctly.

To analyze the science journals, I utilized the rubric to score each of the students. I entered this in a spreadsheet to look at the scores compared to each unit taught. The

scores were entered into the figure to see the growth or lack of growth in the science journals. The science journals were graded once a week in order to collect as much data as possible to show that students understand science concepts better when taught using inquiry method. This was shown through the scoring of the rubric and the effort they put into their science journal.

As shown in Figure 1, 11-hand-on- meaning an activity from chapter 11, has a mean of 34 out of 40 with a standard deviation of 2. The label “10-book” was from chapter 10 and was when the students were using the book. The mean score was 30 and the standard deviation was 2. The yellow section is the average journal scores above the median and the orange section is the average journal scores below the median.

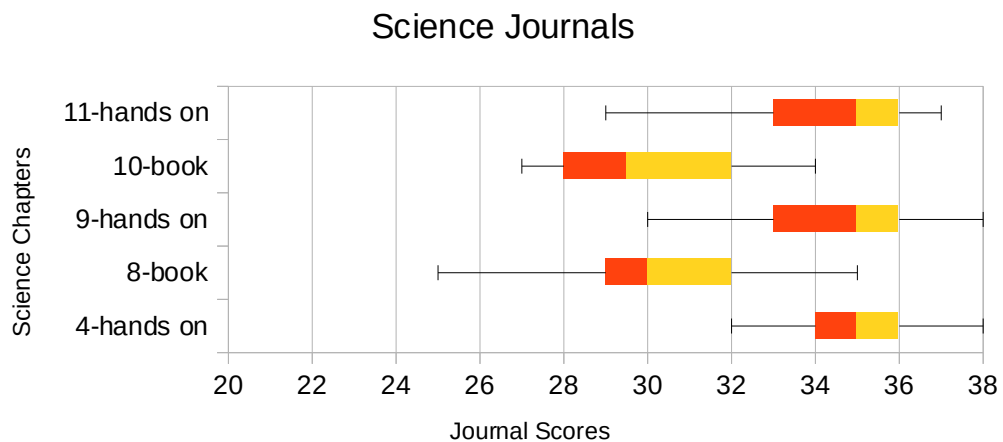


Figure 1. Science journal scores averages, treatment group, ($N=13$).

It is evident from *Figure 1* that students did not put as much effort into their science journals during the unit of traditional type of learning. Some of the students would take notes while others would listen, but not pay attention to the concept being taught. The students who took notes, earned a higher grade for their rubric because even

thought they might have not understood the concept, they at least put effort into trying to understand. The class would put more effort when there were hands on experiments, because they had to record the information instead of taking notes. This may be because they had to record what was going on so they had data to look at with the experiments. When they read out of the textbook they just paraphrased what was read. When they write down information from the experiments, it is their own ideas. This gave the students more control and helped them understand what was going on in the experiment. Over time, the students got into a habit of writing the date and most of the information needed into their journals. The students below the median would continue to not write details unless it was told over and over again. They wouldn't put motivation into the work no matter what was said. The students above the median always wrote details, had dates and were students who would put effort into everything they did. The grade averages for these students were consistently A's and B's with every subject (APPENDIX F).

Test scores shown over five units taught; show that students do better overall with inquiry learning compared to traditional learning. There were outliers, but for the most part, the students did better on tests after inquiry learning. An observation I noticed was the lack of motivation during the second semester, which began in January. Notes taken in January from my journal stated "students not trying as hard with problem solving." Some students continued to excel, while others struggled, even if it was a unit taught with the inquiry approach. The students that continued to not increase in test scores were ones who struggle with testing and have a harder time understanding concepts. In some

instances, it was a processing issue as well as students not taking the time to read questions carefully. Instead of looking at the percentages for tests, I looked at the growth of percentage from one test to the next. An important aspect of my tests was that I allowed students to correct their mistakes for half credit because I felt that they learned from their mistakes, and I wanted them to know what they missed, not just move on to the next chapter. With that in place, I have shown the test scores of corrected tests, if they did, which will be the best score they can get.

Even though the chapters are the same with the science journals and tests, the means and standard deviations are different because the scores were out of a different amount. The mean score for chapter 11 with science tests was 74.5 and the standard deviation was 12.

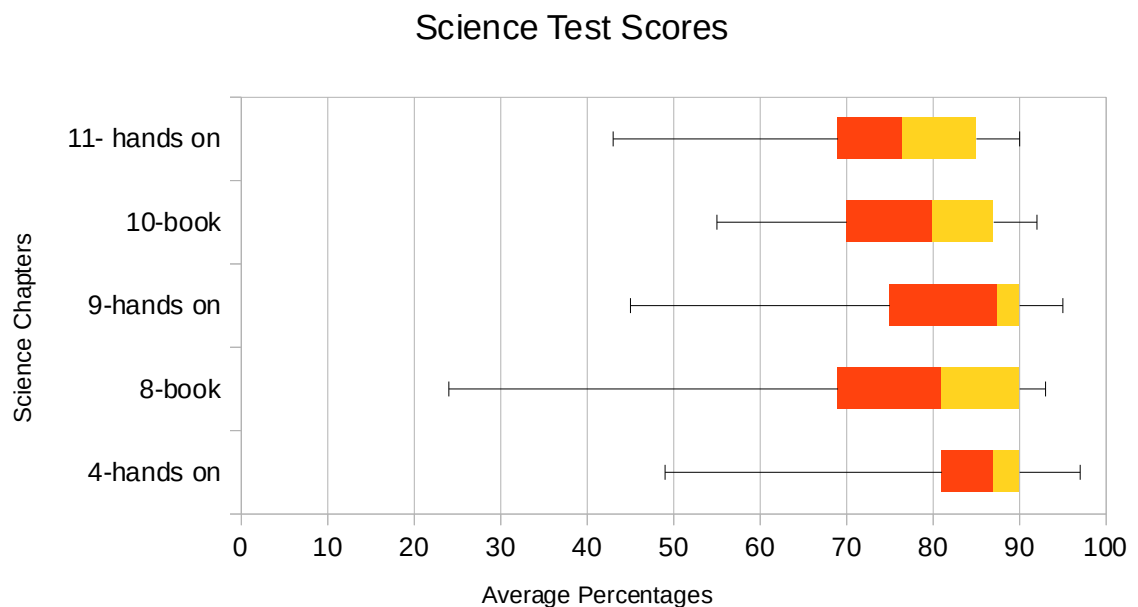


Figure 2. Science average test scores, treatment group, (N=13).

According to *Figure 2*, the students earned higher scores on most of the tests that included hands on experiments compared to tests with traditional type of teaching. This shows that students learn better when using the inquiry method compared to the traditional type of teaching. The average scores did decrease from chapter 10 to chapter 11. Since it was the end of the school year and sixth graders have a tendency to become complacent at school, I feel scores dropped more of a result from this complacency in their behavior than the treatment. Another possible explanation could be the concepts were more complex for this class to understand, but I would need further research to find out why there was a decrease in the test scores. Although there were some outliers, such as students who will always get a good grade no matter how they were taught, overall the scores showed differences between the two different types of teaching. In chapter four, the test scores were overall good, except for one student. Most students are interested in the human body and doing hands on experiments with the human body helped the students to understand the material. With the one outlier, that student had a harder time focusing and understanding the material. That student had processing problems and would get mixed up when taking the tests. General characteristics of students' below the mean were lack of motivation, not listening well, and not wanting to take the time to do the work. One student was afraid to ask questions and didn't want help because she felt dumb. I have noticed that not only with this class, but other classes as well, students don't want to try, but still want to get a good grade. Even though students performed below the mean, I know that they learned through hands on experience based on my observations.

Throughout the entire year, I would jot down notes or observations about the students and their behaviors. Towards the beginning of the year, I observed students putting more effort into their work, as well as their choices in school. While some students continued to make an effort in science, others needed that engagement of hands on experiments all the time. There were always the students that put effort because they wanted good grades, although I wondered if they would still try as hard if grades didn't matter. During experiments, I not only graded their science journals, but I wrote down participation grades for how engaged students were.

An observation I noticed is when we were reading out of the book, a couple of students took notes, but the rest just listened or “spaced out.” When we were doing experiments, they were engaged and writing down the information because they were putting the ownership into their hands instead of me telling them what to do. As the students did experiments, I was always reminding them to write down the information because “that is what a good scientist does.” The grades reflected from the science journals showed that when I was teaching the “traditional” way, students didn't take as many notes or follow along as well. When the students were engaged, they were more likely to write down what they were doing and what they had learned. Another observation was there will always be students that put more effort into their work, but when the students were engaged with hands-on experiments, they do put more effort into what they were doing.

The survey results were an eye opener for me to see how much has changed from the beginning of the year until now. Because this semester I had focused more on

comparing the traditional type of teaching to inquiry teaching, there was an overwhelming response of students not liking reading the book, but enjoying experiments. Sixth grade was a tough year and it showed throughout the second semester how students felt about school. It was evident in the survey that students did not like reading out of the book and realized how much more experiments helped them learn about the material. Too often students thought that just reading about concepts would help them learn, but they needed the engagement of doing the projects to truly think about what they were doing.

In the figure below, “Always-1” means the first time the students took the survey and answered that they “always” do or feel what the question asked. “Always-2” means it was the second time taking the survey and the students answered “always” on the question being asked.

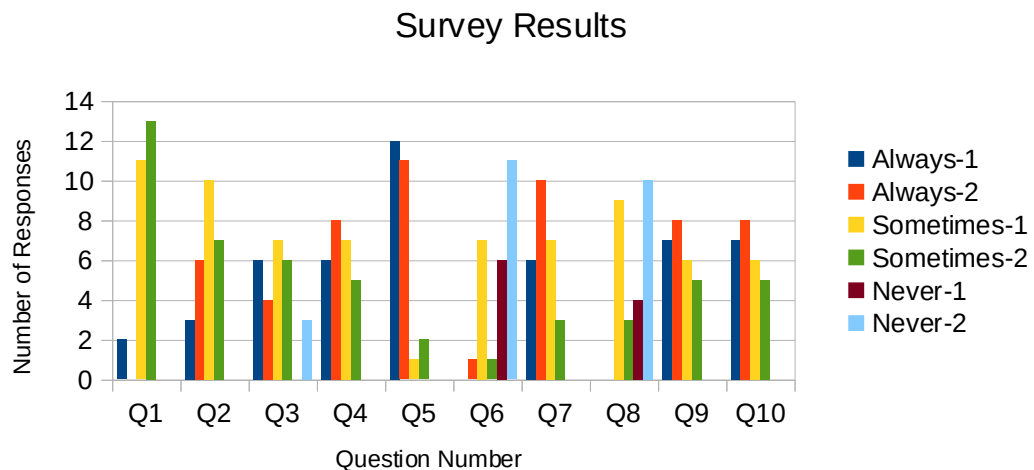


Figure 3. Survey results, treatment group, ($N=13$).

In *Figure 3*, it was evident that most students were encouraged by science and enjoyed learning about science. Overall, the students responded with “never” when the questions revolved around reading out of a textbook to understand science (APPENDIX G). With sixth grade, they have a hard time making up their mind, so I took the “sometimes” as a positive answer to the questions. The biggest change in the answers would be the questions numbered six, seven, and eight which all correlated with whether or not students learned better reading out of a text book. When the students first took the survey they believed that reading out of a text book helped them to learn. After several lessons of just reading out of the text book, then doing experiments, the students learned that hands on experiments helped them to learn better. Through my personal observations, some students just wanted the easy way out instead of being engaged with learning, so they said that reading a text book helped them learn, when in turn they learned better with hands on experiments. Once the students realized how much more they were engaged and enjoying science, they changed their mind about the questions that related to reading out of a textbook to learn about science.

During this entire experience, I kept a journal to observe what happened and how this research project affected me. Although I had taught inquiry in previous years, I was more focused this past year to make sure the students were engaged throughout the lesson and learning as well. In my observations, students were not paying attention during the traditional type of teaching and I had a hard time not using inquiry while teaching that way. “January 5, kids did not like reading from the textbook and had a hard time understanding the subject. Smarter students did just fine”. In the Earth’s landforms unit,

which was with traditional teaching, I had a hard time getting kids to even think about what they were reading. I would try to ask questions to get them to the right answer, but they just wanted the answer given to them. In traditional teaching, the students had a harder time staying focused and comprehending what was being taught.

Watching the students getting excited about science was fun for me to observe and seeing a light bulb go off while they were experimenting. A time when the students were fully engaged was when the class was observing soil and what happened when adding water to soil. I recorded, “the students were so excited with what was happening and were writing down their observations without me reminding them too.” What really helped me to realize the students were learning was when they would continue to ask questions and want to know more about the science subject being taught. One instance in which the students had to ask more questions was when I had the class write down clues to figure out different types of rocks, so the students had to interact with each other to find out which rock the other student was trying to describe. This helped the students realize the importance of details, as well as being able to ask questions to their peers.

Throughout this whole research project, there were challenges and triumphs. The biggest challenge I observed was keeping students focused and on task. From the beginning of the year to the end of the year, some students improved with focusing, but others continued to need redirection. Even with engaging activities, the students wanted me to tell them exactly what to do no matter what we were doing. “The students are needing constant redirection to stay focused.” After Christmas break, I noticed the students not trying as much and needing more help, which I thought it would be opposite.

The biggest triumph was when the students were actually engaged fully with writing down their observations without constant redirection. As a teacher, I need to realize that even changing one student to be more engaged is a feat. By the end of the year, the students expected me to ask questions and challenge their thinking, which is something they struggled with at the beginning of the year. “The students are more responsive when I ask questions and aren’t getting as frustrated”. Although some students would constantly need answers given to them, the majority of the students responded well when I would ask questions. It was ingrained that I wouldn’t tell them the answers, but would ask questions instead.

INTERPRETATION AND CONCLUSION

The data was analyzed to reach a conclusion that the 5E inquiry method piqued students’ interest in science. Inquiry also affected me as a teacher as well as the students I taught. The students were more engaged during inquiry and learned more through this type of teaching compared to traditional teaching. Interviews proved that students liked to do experiment, which can be an important component in the inquiry method of teaching. Students preferred to learn through experiments than read out of a textbook because it helped them “remember what they were learning” (Figure 3). This showed that students wanted to utilize the inquiry method to learn more because it helped them understand the material. After the students were taught both ways, the second interview was more insightful with students actually realizing that doing hands-on experiments helped them learn and understand the material better (Figure 3).

Problem solving skills were a major part of learning and something that I

challenged my class with throughout the year. Through my own observations, I found that the students don't want to be questioned, but in the interview, 8 out of 12 students responded that they are “challenged” and it gets them to “think” when I ask questions instead of telling them what to do. In the interviews, 11 out of 12 students said they preferred to be questioned, and do experiments as compared to having me lecture about the material being taught. This data proved that the students did want to be challenged through different questioning techniques.

Through the tests given in my class, I concluded that overall, the students gained more knowledge when experimenting than just reading out of a book. The students understood the questions better because they dove into the subject instead of just “skimming” over the words to get done. Experimenting took time and helped the students to truly understand the science subject. There were always students that no matter what type of strategies you teach, they will work hard to do well on tests. With my own observation, I noticed students not trying as hard in the second semester of the project, so the tests scores reflect that. The results show that students performed better on tests when they were learning through inquiry instead of reading from a book or being lectured (Figure 2).

Science journals were an important tool that I utilized in the classroom throughout the year. When experimenting, the students wrote down more observations as well as conclusions, but needed to be reminded frequently to write the information down. When reading out of the text book, most students didn't take any notes, but some brought it upon themselves to take notes. Note taking was a good skill to incorporate, but I

wondered how much they were actually learning just by taking notes compared to hands on experiments.

In response to my first question on the 5E inquiry piquing an interest in science for students, it was found that my class became more interested in science through engaging activities and exploring the concepts. Students improved in their problem solving skills and were able to utilize various levels of questions. Inquiry helped me to let kids think for themselves more and guide them to the right answer. Through inquiry, students were engaged and their attitudes towards science improved. This was shown through science journals, surveys, interviews, and tests.

VALUE

As I go forth as a teacher with my class, I hope that they can continue to problem solve by asking questions and gain knowledge from what they are learning. With this study, I hope to use inquiry in other subjects as well to challenge students, but also allowing them to question so that they can understand the material being taught. After analyzing the results, I continued to question the students as well as allowing more hands on approaches. I will also make sure that students take responsibility for their learning instead of the teacher constantly telling them what to do.

The findings in the data showed that any student is capable of learning; you just have to give them the tools to do it and allow the students to explore to find the answers they are looking for. In the rock unit, the students examined rocks, and then came up with their own descriptions for the other students to find the specific types of rocks. This not only had the students exploring the rocks, but also questioning other students to find the

right answer. Other teachers, administrators, parents, and/or community members will learn the importance of allowing students to question and gain knowledge by experiences, not necessarily being told what to do. Inquiry allows students to become more independent and more willing to work hard in this society. Any classroom or school would be able to replicate this project because of the ease of it, as well as how engaging it could be. Some teachers are reluctant to let students explore, but through this project, it proves that students did learn through hands on experiments and questioning instead of just reading information from a textbook or being lectured. Inquiry teaching can be used not only in science, but in any subject, which would make it useful for other classroom researchers. Asking questions and getting students to think beyond the norm, is a tool anyone can use, even in everyday life. Next year I will continue to use inquiry not only in science, but begin using it in all subjects. Students need to be questioned and do hands on work to get their brains going. Through the science journals, I found that using inquiry keeps students more engaged while writing down the information they learned. In the interviews and surveys, the students answered strongly about learning better through hands on experiments, which is something I will continue doing through my science teaching career. All in all, a balance of inquiry and some traditional teaching will be the focus as I continue my teaching career.

The next steps of this project would be to utilize inquiry in every subject area, not just in science. By questioning the students, this allowed them to grow in their academic achievement and become more motivated to do well in school. To research inquiry more in-depth, I would ask how to utilize science journals more with inquiry. I used science

journals, but it would be interesting to do research specifically on science journals.

Another question I would ask would be how students' own thought process can affect their learning. Inquiry can go many different directions, but looking at inquiry in other subjects would benefit any teacher.

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APPENDICES

APPENDIX A
INTERVIEW QUESTION

Participation is voluntary and you can choose to not answer any question that you do not want to answer and you can stop at any time. Your participation or non-participation will not affect your grade or class standing.

Science Interview Questions

Warm up - What can you tell me about your experiences at school?

1. What is your favorite way to learn?
Probe- Give an example. Why do you think that is your favorite way to learn?
2. What motivates you in school? Why? Has it always motivated you? What in school doesn't motivate you and Why?
3. What do you do when there is an idea you don't understand? Do you think it's important that you understand things?
4. How do you know when you understand the material?
5. Which way do you learn best, reading out of a book or doing an experiment?
Probe- Why do you think that is? Can you give me an example of when this happened?
6. Which do you feel helps you learn and understand the concepts or material? Reading a book or doing an experiment.
7. Have you heard of the inquiry method?
What do you think it means?
8. How do you feel when I ask you questions instead of giving you the answer?

9. Which do you feel you learn the best, if I lecture or if I ask questions and you explore different possibilities?
10. Can you give an example of a time where an experiment helped you learn and/or understand the material.
Probe- How did it help you? In what grade to you remember doing experiments? What did you think of that method of learning?
11. Can you use what you have learned in science in the real world? Can you give me an example you remember?
12. What is the best way to show you understand the concepts? Through a test or writing a summary of what you understand.
Probe- How so?

APPENDIX B
SCIENCE JOURNAL RUBRIC

CATEGORY	4	3	2	1
Journal/ Notebook	Clear, accurate, dated notes are taken regularly.	Dated, clear, accurate notes are taken occasionally.	Dated, notes are taken occasionally but it is not organized.	Notes rarely taken or of little use.
Drawings/ Diagrams	Clear, accurate diagrams are included and make the journal easier to understand. Diagrams are labeled neatly and accurately	Diagrams are included and are labeled neatly and accurately.	Diagrams are included and are labeled.	Needed diagrams are missing OR are missing important labels.
Scientific Concepts	Journal illustrates an accurate and thorough understanding of scientific concepts.	Journal illustrates an accurate understanding of most scientific concepts.	Journal illustrates a limited understanding of scientific concepts.	Journal illustrates inaccurate understanding of scientific concepts.
Participation	Used time well in class and focused attention on the task.	Used time pretty well. Stayed focused on the task most of the time.	Participated but did not appear very interested. Focus was lost on several occasions.	Participation was minimal OR student was hostile about participating.
Summary	Summary describes the skills learned, the information learned and some future applications to real life situations.	Summary describes the information learned and a possible application to a real life situation.	Summary describes the information learned.	No summary is written.

APPENDIX C

SCIENCE JOURNAL GRADED RUBRIC

12/1/2014

Your Rubric - Print View



Rubric Made Using:
RubiStar (<http://rubistar.4teachers.org>)

Lab Report : Science Journal

Teacher N:

Student Nar

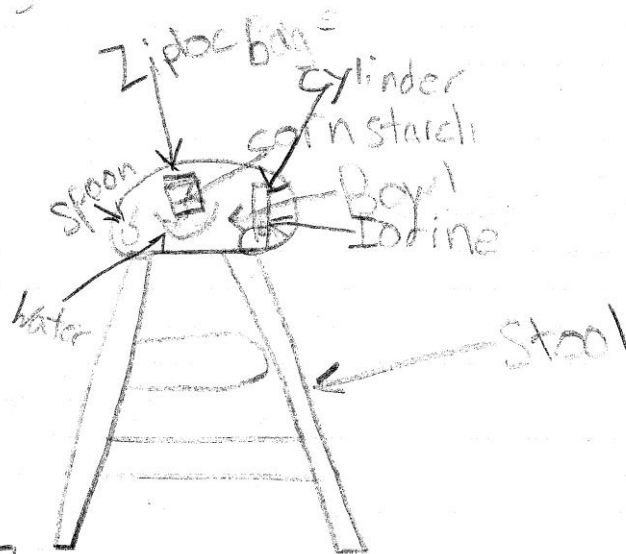
CATEGORY	4	3	2	1
Journal/Notebook	Clear, accurate, dated notes are taken regularly.	Dated, clear, accurate notes are taken occasionally. <i>Dates please!</i> X	Dated, notes are taken occasionally but it is not organized.	Notes rarely taken or of little use.
Drawings/Diagrams	Clear, accurate diagrams are included and make the journal easier to understand. Diagrams are labeled neatly and accurately.	Diagrams are included and are labeled <u>neatly</u> and accurately. <i>make sure they are neat</i> X <i>hard to read</i>	Diagrams are included and are labeled.	Needed diagrams are missing OR are missing important labels.
Scientific Concepts	Journal illustrates an accurate and thorough understanding of scientific concepts.	Journal illustrates an accurate understanding of most scientific concepts. <i>Be organized</i> X <i>Hard to follow</i>	Journal illustrates a limited understanding of scientific concepts.	Journal illustrates inaccurate understanding of scientific concepts.
Participation	Used time well in class and focused attention on the task.	Used time pretty well. Stayed focused on the task most of the time. <i>make you sure stay</i> X	Participated but did not appear very interested. Focus was lost on several occasions.	Participation was minimal OR student was hostile about participating.
Summary	Summary describes the skills learned, the information learned and some future applications to real life situations.	Summary describes the information learned and a possible application to a real life situation.	Summary describes the information learned.	No summary is written.



APPENDIX D

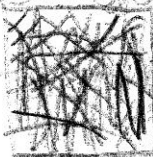
SCIENCE JOURNAL EXAMPLE

10-21-14
Osmosis - Diffusion of water and cells.
Diffusion - equal out substance of high + low concentrations



The corn starch turned brownish white. It turned purple. It turned darker. Darker. Darker. Supplies

I. The iodine dyed the water a light brown. I think that eventually the iodine will dye the corn starch. If a sugar cube goes in a cup of water it will dissolve.



Sugar cube

What is that black stuff?



High Concentration

APPENDIX E
IRB EXEMPTION FORM



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

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 Cheryl Johnson
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MEMORANDUM

TO: Kendra Kanduch and Walt Woolbaugh

FROM: Mark Quinn, Chair *Mark Quinn*

DATE: December 1, 2014

RE: "The Effects of Teaching the Inquiry Method Compared to the Traditional Type of Teaching on 6th Graders" [KK120114-EX]

The above research, described in your submission of November 26, 2014, 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:

- ☒ (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.
- ☒ (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 F
SCIENCE JOURNAL SCORES

Scores are out of 40 and are based off of a rubric being scored.

Name	Chapter 4- hands on	Chapter 8-book	Chapter 9- hands on	Chapter 10- book	Chapter 11- hands on
CB	36	32	37	33	35
IC	34	30	36	31	35
KC	38	35	37	34	36
MG	32	28	33	29	33
PG	34	29	35	28	35
AH	33	28	35	30	36
KH	37	30	36	28	36
DL	36	35	35	32	34
TL	35	30	34	29	34
CM	36	31	38	32	37
PM	32	25	33	27	32
BW	35	33	33	29	32
AW	36	30	33	32	35
EM	*	*	30	28	29

APPENDIX G
SURVEY

Participation is voluntary and you can choose to not answer any question that you do not want to answer and you can stop at any time. Your participation or non-participation will not affect your grade or class standing.

1. I enjoy school.

always

sometimes

never

2. I get good grades in school.

always

sometimes

never

3. I like science.

always

sometimes

never

4. I always try my best in science class.

always

sometimes

never

5. I enjoy doing hands-on experiments.

always

sometimes

never

6. I learn better when I read about science out of the textbook.

always sometimes never

7. I learn better when I do hands-on experiments in science.

always sometimes never

8. I understand the science material better when I read out of the textbook.

always sometimes never

9. I understand the science material better when I do hands-on experiments.

always sometimes never

10. I enjoy school when I participate in hands on experiments.

always sometimes never

APPENDIX H
SURVEY RESULTS

The survey was given anonymously and I told the students they needed to answer truthful.

Question	Always 11-21-14	Sometimes	Never	Always 3-12-15	sometimes	never
1	2	11			13	
2	3	10		6	7	
3	6	7		4	6	3
4	6	7		8	5	
5	12	1		11	2	
6		7	6	1	1	11
7	6	7		10	3	
8		9	4		3	10
9	7	6		8	5	
10	7	6		8	5	