THE EFFECTS OF STUDENTS DRAWING IN THEIR SCIENCE NOTEBOOKS ON THEIR UNDERSTANDING OF SCIENCE IN SEVENTH GRADE SCIENCE

by

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ABSTRACT

In this investigation, student's drawings were implemented with the purpose of gathering information after a passive lesson in science. Students drew after two chapter lessons, one on vertebrates and one on chemistry. The student's final test scores closely (within 10%) reflected their drawing scores. The drawings were found to be a valuable formative assessment and the student's attitudes increased 38% in favor of using drawings in science as a way to communicate science knowledge learned.

INTRODUCTION

During the past eleven years I have been driven to improve my student's success in the area of science education. There are several things like hands on experiences and adding visuals to instruction that have been proven to improve student's interest and ability to learn science. These things have already been added as part of our science curriculum and students have benefited from these additions to the science curriculum at King of Grace Lutheran School. The one area that I believe needed improvement was during the passive lessons in my science class; the lessons that included lecture and note-taking during the chapter. Students seem to be less interested in the science lesson while taking notes and answering questions. I also wondered who understood and who did not understand the scientific concepts presented that day. In education, we have all understood that students have different ways of interpreting, understanding and recalling information taught to them. This may answer the question why some students succeed in a subject or class versus another.

I always enjoyed drawing as a child; I would doodle and draw animals, planes and my favorite athletes. These drawings are still very vivid in my own mind along with the awards I won at the local county art competition. I was never one to think I was really good at drawing, until my third grade teacher entered my artwork in a local competition. I won and felt a sense of relief, thinking I am good at something. In the lower grades, other students were always better at the "core" subjects like math, reading, and writing than I. Only a couple of times after that did drawing enter into other subjects: once in a seventh

grade literature project, where I designed a poster advertising a book I read, then during a high school English class, illustrating a short story I had written. These projects were my favorite and I still remember them and probably still could draw a portion of them today, nearly 20 years later. If I was motivated by drawing for those projects, which of my students might benefit by adding the medium of drawing to science class? Obviously, I enjoyed science; I am a science teacher today. Maybe some of you remember the commercial that showed how Reese's Peanut Butter cups came to be, a guy has a chocolate bar in his hand and trips into someone else with an open jar of peanut butter, and BANG you have this great combination. That is what I believe I am doing in bringing together two of my favorite things in education, drawing and science. Hopefully, after this project, my students will be as happy as many are with Reese's Peanut Butter Cups.

I want to investigate how students' understanding of science is affected by drawing in science notebooks. Will students who excel in art find this project appealing and beneficial to their understanding of the scientific concepts taught? I think it would have helped me as a learner. How can this project benefit me as a formative assessment tool? Can it show gaps in student's understanding of the lesson and therefore make necessary, re-teaching or re-presenting the concept? What are some of the general mistakes that students make when they use drawings to explain their understanding of science concepts? Are the mistakes consistent with other students or does one student keep making the same mistake? Finally, how does adding drawings to the science notebooks affect the teacher? Will it take me hours to grade each drawing done by the class? Will I have students who dislike drawing now dislike science because they have to

draw? In order to answer these questions I have combined them into these specific research questions for my action research project:

1. What effects do students drawing in their science notebooks have on students understanding of science?

2. What impact do student notebooks have as a formative assessment tool?

3. What are the general mistakes that students make when drawing scientific concepts?

4. How will students view of drawing /science change based on the use of drawing in their science notebooks?

5. How will students drawing in their notebooks affect the teacher?

These questions can be asked of other teachers in other subject areas. I know that if I enjoyed and remembered my 7th grade literature project nearly 20 years later, then surely this project could help other teachers and the students they teach. So, it is not just a project solely for science but can be adapted into other subject areas. Fellow teachers at my school will be able to benefit from the steps I have taken so far, apart from the actual drawing portion. Developing surveys for the purpose of polling students about the methods of instruction could lead to many positive changes for any teacher. They could also benefit from using formative assessment to gauge how much the class has learned from a specific lesson, and what areas students still do not understand. Finally, interviewing students one on one or in a group setting can lead to a better understanding

of student's attitudes toward a subject or the teacher. These are excellent new tools I have learned to use by implementing action research into my classroom.

My local support team consists of three colleagues at King of Grace Lutheran School and my mother-in-law who just completed an action research project. Each of these people have strengths that I lack, or they can lend me a fresh perspective on my project. Sometimes I can be too close to the forest to see the trees. These people will help me see the trees and other forests too.

Bill Lubansky- Science Teacher 2-4, King of Grace Lutheran School

Bill has been teaching science in the lower levels for the past seven years. He enjoys teaching science and has taken courses towards his Masters. His passion for new ideas and teaching methods is second to none. He was one of my critical friends in last year's 504 and 505 EDCI courses. He is someone I can bounce ideas off and get honest feedback. I am able to talk with him during recess nearly everyday or after school.

Sherry Lawson- Music Teacher K-3, Milaca Public Elementary School

Sherry is well suited to support me with my AR (Action Research) project. This past June she graduated with her Masters from St. Mary's. In her Masters course she had to carry out an Action Research Project. With her experience on her own AR project, she will be able to assess my project and give constructive criticism. She also will be helpful with my presentation for EDCI 575. Being a music teacher, she has a good grasp of the arts and has useful insight into this project. It should be easy to email or call her to get feedback. She is my mother in-law.

Karen Madson- English Teacher 6-8, King of Grace Lutheran School

Karen's involvement is purely for her expertise in writing. She is well versed in technical writing and how to cite my work in APA style. Karen helped to include the interview statements in an effective manner. She gave the AR project a different perspective, since she is not a science teacher and is not familiar with action research.

Peter Archer-School Board Chairman, King of Grace Lutheran School

My School Board Chairman is perfect for helping me with the data and statistical portion of this project. He was a top mathematics student at the University of Minnesota and student taught high school math before turning to a career in engineering. He helped me to apply Excel to my data analysis section.

This group of people is well suited to make positive changes to my project and give me constructive critism when needed. I also respect each of them and value their input towards an outstanding research project. It was a pleasure working with them on my capstone project.

CONCEPTUAL FRAMEWORK

In my action research project I ask the question, "What effects do students drawing in their science notebooks have on each student's understanding of science?" When reading over all the literature I found three main themes that will help answer my

research question: 1) literature on drawing and learning; 2) literature on applying treatment, and; 3) literature on data collection and analysis techniques.

Combining the drawing aspect with science concepts has always interested me. Because art, along with science, were favorite subjects of mine in school. Research on drawing in science has shown many benefits for student's learning. Through both science and drawing lessons, students learn to develop and apply strategies that enhance critical observation and thinking (Petto and Petto 2009). When exploring the idea of having students draw in their notebooks, one has visions of Lewis and Clark, Darwin, and Audubon. Each of these people successfully brought together art and science. Their observations were drawn in a notebook (field notebook), allowing them to communicate their science ideas to others through pictures. The NSES *(National Science Educational Standards)* Science Content Standards state that more emphasis should be placed on "communicating science explanations" (NRC 1996, p. 113). In using drawings, students combine art and science in communicating ideas in science to the teacher and other students. Sallis, Rule & Jennings (2009) found that "much research and development has been done on developing students' abilities in this creative domain, but little has been purposefully incorporated into science programs" (p.2). Using the science notebook as a way for students to visualize a concept may be able to help students in combining different learning styles to be more successful in science. In my own education, art and drawing were heavily used in lower grades and less and less as the grade levels increased. I can remember very few lessons or projects that integrated art or drawing. Art and drawing activities tend to serve as an extension or "filler" activity, and student-generated

drawings are rare. This may be due to the teacher's lack of confidence in their ability to use art as an instructional strategy (Baum, Owen, & Oreck, 1997, p. 37).

There are several pieces of literature that helped me understand the connection between drawing and the learning process. I was fortunate to talk via phone with Professor Richard E. Mayer, University of California, Santa Barbara, who is one of the leaders in using visuals to learn. His foundational research with *Illustrations that Instruct* (1993) has laid the groundwork for using scientific drawings to capture information pictorially and aid student understanding." He forwarded me an article that has yet to be published (in press) titled *Drawing During Learning* by Annett Schwamborn, Duisburg-Essen University. Professor Mayer, along with three others, assisted Annett with her research. Her research showed that students who were instructed to "generate drawings during learning, scored higher than students who only read the text." (Schwamborn, 2010, p.9). Her research supports the work done by Paivio and Wittrock (Mayer, 2011) on generative theory. Both of their perspectives view the drawing process as a generative cognitive activity that is beneficial for understanding new concepts. Paivio believes that information is coded and represented both visually and verbally in one's memory. When concepts are presented to a student in a visual and verbal way they are coded in different channels of the brain. In order to bring both channels together, they need to correspond or link up to each other. In my action research project, the link or correspondence will be the drawing. As mentioned before, drawing is a generative cognitive activity. The text and drawing are linked and matched for agreement in the student's mind. Schwamborn's research concluded that, "Asking students to generate drawings while reading a science

text resulted in better learning outcomes than not asking students to generate drawing while reading" (Schwamborn, 2010 pg. 874).

Mayer describes four types of illustrations: decorative, representational, organizational, and explanative. He mentions that there is consistent evidence that explanatory illustrations, which explain how a system or a process works, have more impact than the other three types of illustrations on cognitive processing and meaningful learning. Mayer also points out that science textbooks devote 50% of space to illustrations, with fewer than 10% of those illustrations presenting explanatory pictorial models of concepts. Explanative illustrations support cognitive processes required for meaningful learning by helping the learner select, organize, and integrate the words and images into a clear mental model. Such illustrations aid the selecting and organizing processes by focusing the learner's attention on conceptually relevant information and helping the learner to build connections between visual and verbal components (Mayer, 1993). The process of drawing then becomes a bridge that connects the information given in a verbal form, text and lecture, and the viewing of material, photos, and video clips with proper labels or explanations. The research shows that drawing as a creative expression has value and can be used to increase retention of science concepts.

Knowing that drawing is beneficial in learning science concepts is part of my research. Now how do I apply it to the classroom so that it is effective? I have also learned from (Schwamborn, 2010) that students need minimal instructional support, such as drawing prompts, to make their drawings more effective. In not instructionally supporting my students I could slow or impede their learning of the science concepts, since their minds are too focused on the actual mechanics of drawing. In order to

minimize this problem, I will use a textbook, lecture, and notes to provide the verbal component of the lesson. The use of video clips from the Windows on Science (Optical Data Corp., 1997) videodisc curriculum allows me to bring the visual component into each lesson. This curriculum has many explanatory illustrations embedded in rather large laser discs. I also will use hands on models whenever applicable. Usually in chemistry lessons, the basic organic chemistry set with colored spheres and sticks is used. These sets may help students visualize concepts in chemistry.

I have also learned that students need time and encouragement to complete their drawings and not all artistically gifted students can draw. Allowing time for students to complete their drawings came up in (Pillsbury 2006) and (Sallis, Rule & Jennings, 2009). Pillsbury's article also helped me to make a decision on whether to ask students to color their drawings or not. He only allows pencil medium on rough drafts, which allows for re-drawing some parts and not rushing. Some students will even take their drawings home and re-work the drawings or even start over. "Students may not use color on any of their diagrams until the entire scroll is penciled" (p.24). At first the drawings are sloppy, and stick figures are normal, which he cites as "acceptable and even appropriate." He mentions this as important so all student attempts will be successful. The student's sketches may be crude at first, but he also mentions that, "some students exhibit some initial frustration" (p.23). Frustration in drawing concepts is common, and he normally gives students a few minutes to fix their drawings. This gives students time to finish up confidently. In order to provide encouragement and enough time for students to complete their drawings, I will walk around the room and let students know they should "do your best" and that "these drawings are personal to you." While observing, I'll point out the

positive aspects of their drawings like: “nice feather,” “you’re doing a nice job”and, “I like that.” I will also monitor their progress as it relates to time, then record this in my teacher journal. I will give students approximately 4-6 minutes to complete drawing the concept, I have asked them to illustrate. This seems to be plenty of time, since students are using pencils only and not coloring the concept.

How to collect and analyze the student data was covered in a couple of articles I reviewed. The article, *In their Own Voices*, by Karen Lee Carroll (2008) provided me with some excellent interview questions. In her research, she interviewed students on how they learn best. Some of her questions guided me in the making of my survey form (Appendix A) and interview form (Appendix C). Here are Carroll’s open-ended questions: What do you know now about how you learn best; What advice would you give to a teacher who might come across another student like you?; How can teachers help you be and feel successful as a learner?; What should teachers try to avoid?; and, What did not work well for you? (p.38). Carroll then broke down the qualitative data into these groups: Show me; Let me do it; Give me time to process; Encourage me!; peer dialogue and conversation; one on one instruction; and, multiple teaching strategies. As mentioned earlier in this literature review, allowing student’s time is a key element for my capstone project. Students need time and Pillsbury (2006) offered some solutions to that problem by allowing some students to describe their diagrams of science concepts. Giving students time also covers the peer dialogue and conversation statement. The Show me! and Let me do it! is often covered in the science teacher field with hands-on labs and demonstrations. In adding drawings to science notebooks, more learning styles could be covered.

In grading the students drawing I needed to create a rubric that was reliable for my Action Research project. The rubric I developed (Appendix B) is made up of categories that other researchers have found useful. One of the catorgies is accuracy. Some students will generate high accuracy drawings and some low accuracy drawings. Accuracy is defined as "the degree to which completed drawings resemble the represented object(s)" (van Meter & Garner, 2005, p.299). In reviewing Cartooning *Your Way to Student Motivation*, by Sallis, Rule and Jennings (2009), the rubric used for scoring student work had two categories that caught my attention. One was the "statement of science content displayed by the cartoon" (drawing). That is to make sure that the science concepts drawn make scientific sense, or that they contain the correct labels. The second item that I liked was, "sufficient details drawn (talking bubbles, captions, characters, and elaborations) to make the cartoon understandable" (p. 25). I incorporated these items when making up my rubric. In scoring the rubrics (Schwamborn, 2010, 877) the scoring was done by assistants and provided the researcher with inter-rater reliability. I did ask our 5th grade teacher to help me grade the drawings, but she declined, due to other commitments.

Using drawings as formative assessments was mentioned by (Sallis, Rule, & Jennings, 2009) that drawing was a tool that could uncover student's misconceptions of science concepts. In talking with Professor Richard Mayer, he suggested that I create a **catalog of student mistakes** that are found in their drawings. This may lead to a change in the way I teach a specific concept in lecture or lab. The idea of formative assessments was addressed in EDCI 504, a course at Montana State University, and will be a rich

source of data to improve student learning. The specific errors will be entered into the catalog once the drawings have been graded.

The literature review has given me insight into my action research project and has changed the way I view student notebooks. I have gathered further guidance in these three areas: 1) literature on drawing and learning; 2) literature on applying treatment; and 3) literature on data collection and analysis techniques. Gardner's multiple intelligence theory (1983) shows that students exhibit intelligence in many different forms. I was able to find those students that gravitate towards visual, spatial and kinesthetic learning during the course of my action research project. Maybe a student will discover the value of drawing and continues to use it as a method that works for them. My job is to help students learn science and to do so I must employ different methods for different learning styles.

METHODOLOGY

The treatment for my AR project asked students to draw at the conclusion of a passive lesson. In the past I have had students take notes from the board and watch clips from the Windows on Science curriculum. These two methods needed to be brought together to identify student understanding; hence, the drawing in the science notebook. I currently teach 5^{th}-8^{th} grade science at my school; the classes being 40 minutes in length, 5 days a week. The 7^{th} grade science class is the class I used with the treatment. This class took the pre- and post-treatment survey, pre- and post-chapter tests, and participated in interviews that helped me find out their attitudes toward treatment chapters. This class was well suited for the task, since it is my homeroom class and I could find extra time

during the day to conduct the surveys and interviews. This class also has 21 students, which is the largest in our small school. This supplied me with more data to work with as I analyzed the drawings, surveys, interviewed students, and compared pre- and post-tests.

My treatment starts with having each student take the initial survey to gain insight into their thoughts and feelings toward science, art, and drawing. Each lesson in a treatment chapter will usually have objectives listed in the textbook. These objectives are a guide so the students know what they will be asked to draw at the end of the passive lesson. Since science textbooks are filled with illustrations or photos, this too can help in determining what I ask the students to draw. I then proceed with the lesson as normal, with basic question and answers, lecture, notes, and the use of visuals, which are key to this project. Next, I give students either a still picture or a short video clip that allows students another way to process the information as part of learning the concept. This visual representation of the concept is necessary, especially for students with limited prior knowledge of a particular scientific concept. Students with a deeper base of prior knowledge on a particular scientific concept will benefit from this refresher as well.

An example of applying this to a classroom is as follows: When the class learned about the differences between contour and down feathers of birds, the class answered questions, discussed, took notes, and saw the characteristics of birds. They also saw a picture of a contour feather, which is used in the birds' flight, and a down feather, which is used in keeping the bird warm. At the end of the lesson, the students were asked to "draw the two feathers that most birds have, label them, and explain the role each plays in the bird's survival." The students were then given 5-8 minutes to complete this drawing, in pencil only as I walked around the room to observe and monitor their progress. I

provided positive encouragement by telling students what I liked about their drawings and told them to “do their best.”

Once the students complete the drawings for each of six lessons in the chapter, I scan them into my computer and make photocopies of their drawings to grade, according to the scientific drawings rubric (Appendix B). The rubric provides me with the data needed to answer the questions for my AR project. The drawings are used as a formative assessment to gain insights into my teaching of a particular lesson. For example, students may leave out details or not label an item. This may then allow me to “close the loop” on that lesson before the summative assessment and make the necessary changes to the lesson before I teach it again.

During the summative assessment or final chapter test, I included the same fill-in-the-blank and multiple-choice questions as the pre-test. During the interviews, all the students said that in the future I should add a section of questions that require us to draw and explain topics covered in the original lessons. Initially, I wanted to include essays on the pre-tests and drawings on the post-tests. This was ellimated due to little or no information gained from the pre-test essays. Students often copied other areas of the test or just wrote, “I don’t know this stuff.”

The treatment chapters chosen were 5 and 9. Each brought a different element to the project; Chapter 5 was on vertebrates, while Chapter 9 was on chemical changes and how atoms combine to form compounds. These two chapters are different in the concepts that students learn and with what students are visually familiar with. The vertebrate chapter has animals that all the students have seen before in nature or on television. The concepts in Chapter 9 have never been seen by anyone, at least at the atomic level. I was

interested to find out which chapter students found easier to draw and how it was related to their drawing ability. Of course, some said “neither were easier for me.” Below is a chart of the chapters and lessons covered in treatment and non-treatment chapters.

Table 1: Chapters and Lessons

Chapter 5 Vertebrates		
Lesson Title and Date	Objectives:	Students asked to draw
5.1 Traits of Vertebrates 10/12/10	• Define vertebrate • Describe the skeletal and nervous system of vertebrates • Compare cold-blooded and warm-blooded animals	Draw and label the differences between cold and warm-blooded animals.
5.2 Fish 10/13/10	• Describe the traits of fish • Compare the three classes of fish. • Describe the sense organs of bony fish.	Draw and label all the characteristics of a fish we learned about today.
5.3 Amphibians 10/14/10	• Describe the traits of amphibians • Give examples of	Draw and label the different groups of amphibians.

	amphibians from the two major groups. • Describe the metamorphosis of a frog	
5.4 Reptiles 10/15/10	• Describe the traits of reptiles • Compare reptiles and amphibians • Distinguish between the major groups of reptiles	Draw and label the different groups of reptiles
5.5 Birds 10/16/10	• Describe the traits of birds • Relate the structure of beaks, feet and feather types to their functions • Describe the structure of a bird egg	Draw and label the two different types of feathers most birds have, and explain their function
5.6 Mammals	• Describe traits of mammals	Draw and label how the three groups of mammals

10/19/10	• Distinguish between the three major groups of mammals • Give examples of placental mammals.	we studied today bring their young into the world

Chapter 9 Compounds		
Lesson Title and Date	Objectives	Students asked to draw
9.1 What is a Compound? 1-7-11	• Define the term compound • Compare compounds and elements	Draw and label the differences between elements and compounds
9.2 Symbols and Formulas 1-10-11	• Define the term chemical formula • Interpret chemical formulas • Identify several compounds when given their formulas	Draw and label in order to interpret a chemical formula
9.3 Ionic Bonding 1-11-11	• Define the term ion • Explain how ionic bonds form	Draw and label how ionic compounds form

9.4 Polyatomic Bonds 1-12-11	• Explain what a polyatomic ion • Describe how polyatomic atoms make compounds	Draw and label how polyatomic ions make compounds
9.5 Properties of Ionic Bonds 1-13-11	• Describe the properties of ionic compounds	Draw and label the properties of ionic bonds
9.6 Covalent Compounds 1-14-11	• Explain how a covalent bond forms • Describe properties of covalent compounds • Compare properties of covalent compounds and ionic compounds	Draw and label how covalent bonds form or bond

The treatment chapters also include student interviews, post-tests, collection of students drawing mistakes, and my teacher journal. These instruments will allow me to collect data to answer my AR question, "*What effects do student's drawing in their*

science notebooks have on students understanding of science?" and my four sub-questions.

In the non-treatment chapters the lessons are taught exactly the same, minus the element of drawing at the end of each lesson. In commenting to the students that the chapter currently being studied was a non treatment chapter, some students questioned what that meant. When it was explained that we would not be drawing in this chapter, they were groans of disapproval, while others pumped their fists in gladness. So, there are definitely some who like the treatment and some who do not.

RESEARCH METHODS

The following data collection techniques are to be applied to answer my research questions: Chapter pre- and post-tests, student interviews, surveys, general catalog of mistakes, student's drawings, and a teacher journal. Below is a matrix that shows the ways I will use the data collected to support my research questions.

Table 2
Research Matrix

		DATA	**SOURCES**			
	1	**2**	**3**	**4**	**5**	**6**
Data Collection Matrix:	Pre-test/ Post-test	Student Surveys Pre & Post	Semi Structured Student Interviews	Rubric Scores of Student Drawings from Science Notebook	Teacher Reflective Journal	Catalog of Student Mistakes
Research Questions						
What effects do students drawing in their science						

notebooks have on student's understanding of science?	X	X	X	X		
What are the general mistakes that students make when drawing scientific concepts?				X	X	X
What impact do student notebooks have as a formative assessment tool?		X		X		X inst
How will students view of drawing /science change based on the use of drawing in their science notebooks?		X	X			
How will students drawing in their notebooks affect the teacher?			X	X	X	X

Key: X = will be used in determining conclusion to question asked.

Quantitative Data Sources: Pre-test/Post-test; Rubric Scores; Catalog of Student Mistakes.

Qualitative Data Sources: Surveys; Interviews, and Teacher Journal.

In looking at this extensive list of data collection techniques, I am overwhelmed at times at the depth this project required. I recall the days in which I did not even know what a formative assessment was and now I can teach others how to use them. I will now elaborate on how each of these tools will help me answer each question I have asked. 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.

The first tool is the pre- and post-tests that the students take for a chapter that is taught. These tests will be analyzed to answer student understanding of science concepts. Some students who scored well on the pre-test most likely had greater prior knowledge of the subject, while the opposite would be true of lower scores. Prior knowledge was likely a variable in this project. The same test is used for both the pre- and post-tests which increased reliability in my research.

The student’s notebooks or drawings were the second tool, and gave me insight into their misconceptions or mistakes. They also helped me understand the role drawing can play as a formative assessment technique. This provided me with the answer as to whether or not student’s drawings let me “see” their misunderstandings and make changes to my specific lessons.

The surveys that the students took helped me see how student’s attitudes have changed. Many students changed their attitudes towards drawing and the use of it in their

learning. I think at this age students really do not think about how they learn science or a subject. Some students that had reported that they did not like assignments that required them to draw, changed their minds and found it a valuable tool in their education. The surveys also gave me insight into the students that I interviewed. The surveys have provided two groups of students to interview. Both groups of students enjoyed science as a subject; one group liked drawing, while the other group disliked drawing.

The interviews provided insight into the thoughts and attitudes of my students. They were free to tell me why they liked or disliked the treatment chapters and offered some changes I can make going forward. When I did my pilot interviews it really gave me some terrific insight into this project. I think as teachers we often overlook the most important resource apart from ourselves, the students. One must be prepared to hear everything, good and bad.

I struggled the first few months to come up with a solid rubric. However, with help from colleagues I was able to come up with a rubric that had three simple categories: scientific detail, labeling, and accuracy. The rubric helped me see what mistakes students made on each concept, and how drawing can be used as a formative assessment. It also showed the student's understanding of science concepts. In the lesson on birds some students incorrectly labeled the down feather as the contour feather. This is a simple mistake and easily corrected when pointed out. The students had the correct elements, both feathers. The drawings were accurate, which means they closely resembled the represented object(s). They only mislabeled the drawings, and since the drawings were accurate, I was able to point out the shape of the contour feather, asking "which one

could take the bird on a *tour* of the state?" The students quickly made the connection to the word *tour* and flight, relating it to the wing like shape of the contour feather.

The drawings are time-consuming to view and grade, which is something I added to my teacher journal. The journal helped me to answer the question. How does this research affect me as a teacher? In my journal I have the same four questions for each entry. Using the same four questions gave the journal more reliability as a research tool.

The catalog of mistakes helped answer the question concerning drawing as a formative assessment technique. The list of student mistakes had affected my teaching. Will a high number of mistakes push me away from this method or will it drive me to make it better? It could lead me into more questions. For examples: Are there enough visuals? Are labeled visuals better? Do students with more prior knowledge of a subject make fewer mistakes? This catalog could lead to many more action research projects.

When all the above data sources are triangulated they will help answer my research questions and come up with a conclusion that has validity. Each question has more than one data source to formulate an answer. The matrix is a wonderful visual tool to see how I will use each piece of data.

My Class

The research sample included all 21 students in 7th grade. The class was comprised of 13 girls and 8 boys. The students at King of Grace come from families that are from lower middle class to upper middle class. The 7th grade class included these demographics: 17 Caucasian, 3 African American, and 1 Korean student. Data was not analyzed based on ethnicity. No students received free or reduced lunch.

Data and Analysis

In looking over the data that was collected over the period of six months and four chapters, two being treatment chapters, I found myself with a great deal of information that leads me to answer my questions in a confident and valid way.

The first instrument that I used was the initial student survey. This survey (Appendix A) was given in the fall of 2010, and it listed questions dealing with drawing, art, and science. The survey gave me tremendous insight into the attitudes and thoughts of the twenty-one students in my class. I collected this data for the survey during a treatment week and before the post-assessment test. After taking the survey, I turned all student responses into a number value or quantified data. Each of the four possible responses was given a number. Below is an example:

Strongly Disagree	Disagree	Agree	Strongly Agree
1	2	3	4

This survey contained fifteen questions which were designed to help me clarify students' attitudes towards school, art, science, drawing, and how students learn science in my classroom. The students were excited and willing to help me by taking this survey; they were quiet and focused during the survey. I was glad to see that there were no unanswered questions on the survey because this could create some issues down the road. After the initial survey, I found I had two distinct groups of students. The first group was students who enjoyed science and enjoyed drawing (76% of students). The second group was students who enjoyed science but disliked drawing (24% of the class). This last group is one that I will analyze to determine how the treatment chapters affected them.

This group is diverse as far as science grades and art ability. I will refer to this group with student numbers as follows:

#7: Female

#11: Male

#13: Female

#16: Male

#22: Male, who does very well in art/drawing.

Overall, I was glad to see that so many students enjoy science as a subject. This can lead to a better learning environment. Since they enjoy the subject, they have motivation to do well in science. Reasons for this could be as one girl wrote, “It’s the teacher here, honestly, that makes it fun!” This young lady also said, “I enjoy drawing in science,” and was in the group that liked the treatment chapters.

In the group that I will focus on, those who disliked drawing in the science notebook, there were three boys and two girls. Two of these students consistently make the “A” honor roll while the other three are typically “B” or “C” students in science. I was surprised to see one young man in this group. He is typically a “B” or “C” student in most classes, but he is talented at art and drawing. I determined this treatment was perfect for him, and that he would truly enjoy it.

During the interview, all five students told me that they have used drawing in other classes like art, social studies, and literature class. Therefore, they have experience with the drawing during different academic subjects. All five said “no” when asked if drawing helped them learn the subject matter better. One girl elaborated and said, “I don’t learn that way.” When you look at her survey answer, this also was confirmed. She

circled *strongly disagree* when asked if she learns science visually. The others indicated that they do learn visually and wrote they like to watch videos and do hands-on labs when learning science.

The students' drawing ability varied greatly within this group, which surprised me. In my journal I wrote, "I was shocked that #22 does not like drawing in his science notebook. He is a great artist." He had mentioned in the interview, "I don't like being told what to draw." Even though this is a method that he enjoys, his attitude is a factor when it comes to this treatment.

The other students in this group were either uncomfortable with art in general or not confident with their ability to draw what was assigned. Three of them said they were not comfortable with assignments that asked them to draw. Two of the students thought that they lack the proper skills to draw science concepts. Student #7 lost 11 points on accuracy alone during the first treatment chapter. Her overall average for Chapter 5 drawings was 8/12. She scored 68% on her drawings and 77% on her final test for Chapter 5. This type of score would be only percentage points lower (80% norm) than her normal science scores. This is her first year at our school and was probably still adjusting to the new environment.

This was also seen in their rubric scores on their drawings during the vertebrate chapter. These students scored 8/12 and 6/12 on the reptile and mammal drawings. These drawings were more complex than the bird feather drawings in which they both scored a perfect 12/12. In my journal entry, I recorded "try and keep the drawings as simple as possible." Three of the students mentioned their lack of drawing ability does affect their view of the treatment chapters. One said, "If someone looks, they won't like it; it drives

me crazy when I know I can do better." Another mentioned, "It kinda affects me; I know I'm not a good drawer." And another wrote, "Yes, I don't know how to draw what the teacher is asking me to draw." This last comment was from a student who scored an average of 68% on her drawings in the vertebrate chapter. One student scored 52% on his drawings and then scored 100% on the final test. This student is not very strong in art and drawing in general, and he did lose a number of points in the accuracy category on the drawing rubric (Appendix B). In the future I would weight each category in the rubric in order to focus on the scientific details and labeling.

The worst and best part of having students draw vertebrates is that they know and have seen these animals since preschool. The entire class's prior knowledge was seen in their pre-test scores when they averaged 69% as a class. The entire class improved to an average of 91% on the final test. In performing a t-test on all the pre- and post-test scores, no significant difference was recorded between treatment and non-treatment. Student #11 scored 87% on the pre-test and then 100% on the final. The five students who do not like to draw scored as follows: 70, 73, 53, 77, and 63 percent on the pre-test. On their drawings, these students averaged as follows: 68, 83, 83, 82, and 88 percent. They scored 77, 87, 93, 93, and 93 percent on the final test. As you can see, their drawing scores were similar to their final test scores. This leads me to see the value of this treatment as formative assessment technique since the drawing scores and final test scores are not greatly different. In the interview process, 10/12 mentioned that it helped to review their drawings before the final chapter test. In looking at the graph below you can see how most student's drawing scores related closely to their final test score. There are two students whose scores are quite discrepant in comparison. Students #11 and 17 scored

much lower on their drawings than on their final test scores. These two students both do not like learning how to draw in art class, and both strongly agreed they enjoyed science as a subject. Both students thought they were good at science. Student #11 did not think she learned by visuals, while student #17 said "it helps me to see them and not just talk about them." In looking at their drawings, student #17 left items unlabeled in three of his chapter 5 drawings, while student #11 wrote more than she drew. In each case the scientific details were present. These two students both ended up enjoying the treatment chapters and raised their drawing scores in the next treatment chapter.

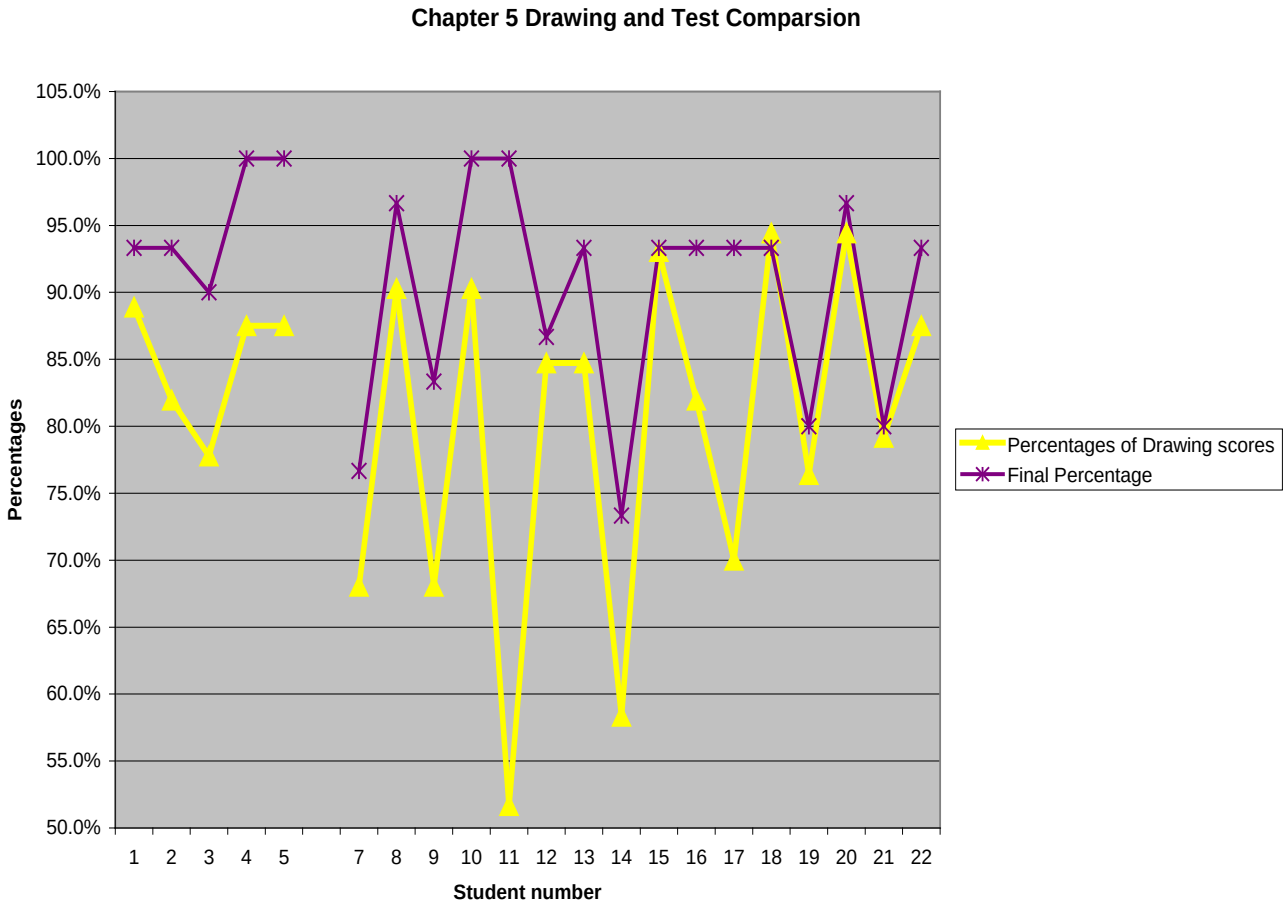


Figure 1. Comparison of drawing and final test percentages for chapter 5 (*N*=21, *student 6 transferred)

On the final survey, I asked the class what treatment chapter they thought was easier to draw. The response was that 12/21 said “vertebrates.” Four of the five students in the group that I focused on thought that vertebrates were easier. This was due to the fact that the other treatment chapter was on chemical compounds. One girl said, “Chemistry is harder to draw; I’ve never seen an atom.” Another student said, “Animals were harder; I don’t know how to draw them. Electrons were really easy, not as much details; they’re not animals.” I was surprised how many students thought that drawing animals was easier since their overall drawing scores were lower than the chemistry chapter. I would think that drawing balls and sticks would be far easier than animals. This is due to having a great deal of prior knowledge about animals or vertebrates. Many more points were deducted due to accuracy issues when grading the vertebrate drawings.

In looking at the *Catalog of Student Mistakes,* the first treatment chapter had thirty-nine incidents under the category, Trouble Distinguishing Details, as compared to only five incidents recorded in the same category for the second treatment chapter on chemical compounds.

Table 3. *Catalog of Student Mistakes*

Chapter 5 Vertebrates

Mislabeled Unlabeled	Omitted Details in Drawing	Trouble Distinguishing Drawings	Misconceptions Within Assigned Drawing
32	38	43	10

Chapter 9 Compounds

Mislabeled Unlabeled	Omitted Details in Drawing	Trouble Distinguishing Drawings	Misconceptions Within Assigned Drawing
30	16	5	16

This category distinguishes what was drawn without a label. The vertebrate treatment chapter had far more mistakes in distinguishing details than the compound treatment chapter. Two factors lead to these mistakes: the student's ability or lack of ability to draw a particular animal or feature, and the grading choices of the grader.

In looking at the *Catalog of Student Mistakes*, students made more conceptual mistakes in the abstract lessons on chemical compounds, a total of sixteen, versus ten in the more concrete lessons. Examples of mistakes made in each category are as follows:

1) Mislabeled or Unlabeled: Students did not label scales on the fish drawing.

2) Omitted Details in Drawings: Students did not draw eggs along with the platypus.

3) Trouble Distinguishing Drawings: Student's drawing was not clear, was messy, was without a label, or it would be hard to recognize (example: a kangaroo that looks like a vampire bat).

4) Misconceptions within Assigned Drawing: Student draws water as an example of an ionic bonded substance when it is a covalently bonded substance.

The class as a whole scored lower on their drawings of mammals with a class average of 69% as compared to the lowest chemistry drawing average of 83% which was on polyatomic ions. One student's comment summarizes this difference between the two treatment chapters saying, "All you have to do is draw balls and sticks." The five students who disliked the treatment chapters preferred drawing vertebrates. Student #13 commented, "They (animals) were real things that had a shape and a look." Another

student said, “I find them easier (to draw).” On the final survey (Appendix D), I asked some additional questions, numbers 16-19. Question 17 asks students the following: *It was easier to draw in the chapter that dealt with: Animals (Chapter 5 or Chemistry (Chapter 9) or none were easier*. The final results were shown on the following graph:

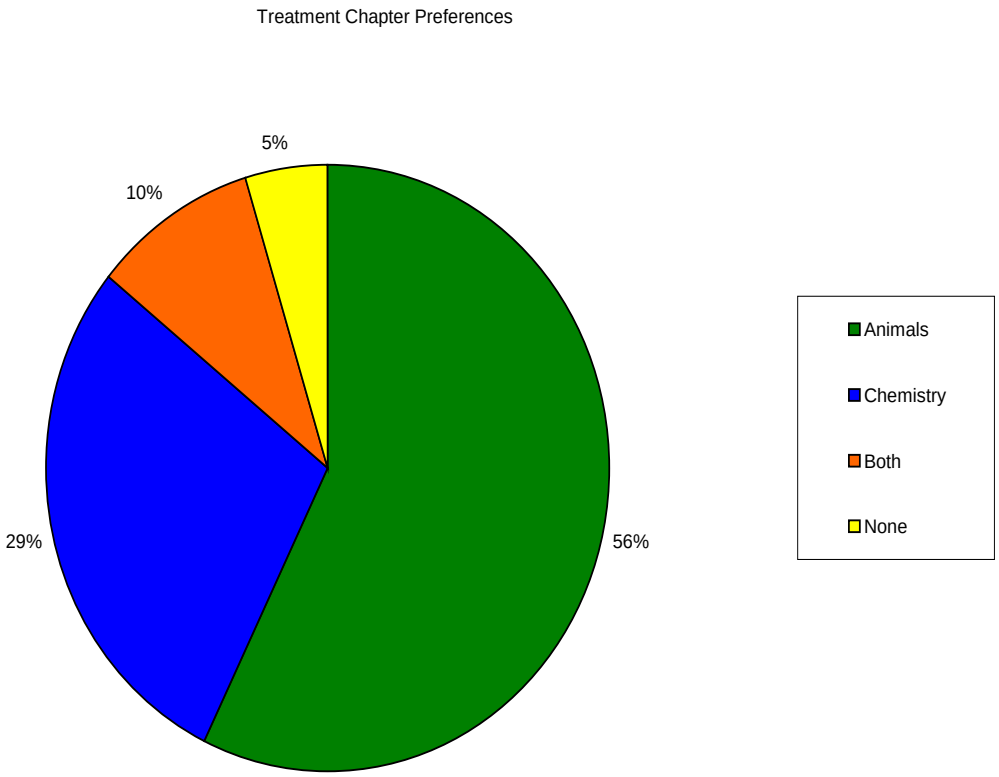


Figure 2. Responses to survey question on which treatment chapter was easier to draw (*N*=21).

There was no correlation between students who like art or drawing and those who do not like art and drawing. I had expected that the twelve students who thought that drawing animals was easier would have been more into art/drawing. I also had expected students who struggled in art/drawing would have found chemistry easier. In reality, the

class members made their decisions based upon which chapter was easier to understand and visualize. Paivio calls this concreteness effect (Mayer, 2011). Concreteness effect is explained in Mayer's book, Applying *The Science of Learning,* as: The finding that people can remember concrete words such as *tree* better than abstract words such as *style*.

Students' ability in art or drawing had mixed results. I have already mentioned student #22 who is talented in art/drawing, yet did not like the treatment units. This was the same result with student #12. Other students in the group seemed to enjoy aspects of the treatment units. Two of the students who disliked the treatment units, #7 and #12, now agreed on the final survey that they are comfortable with assignments that required them to draw. Student #7 said, "I understand it more," when referring to drawing after a passive science lesson. It does not seem to matter whether or not you're good at drawing; it only allows the images to be clearer. Even if a student has lower ability to draw for accuracy, I was always encouraging the class with the constant mantra, "Do your best!" and, "Your drawings are personal to you and not public." I was interested to see for myself, as a teacher, the differences between students' drawing abilities and how it affected their view of the treatment chapters.

In the second treatment, Chapter 9 compounds, the five had far fewer mistakes in two categories, Omitted Details in Drawing and Trouble Distinguishing Drawings. This is due to the simple nature of chemistry drawings. As one of them mentioned, "I've never seen an electron." These drawings were more open to student interpretations. The class as a whole faired better when it came to accuracy on the rubric. It was a great to see student #16 express his ideas of elements and compounds with textual-type drawing of Bohr

models. The Bohr models were something that I taught in Grade 6 the previous year. The best part was his accuracy. He had the correct amount of electrons for each shell.

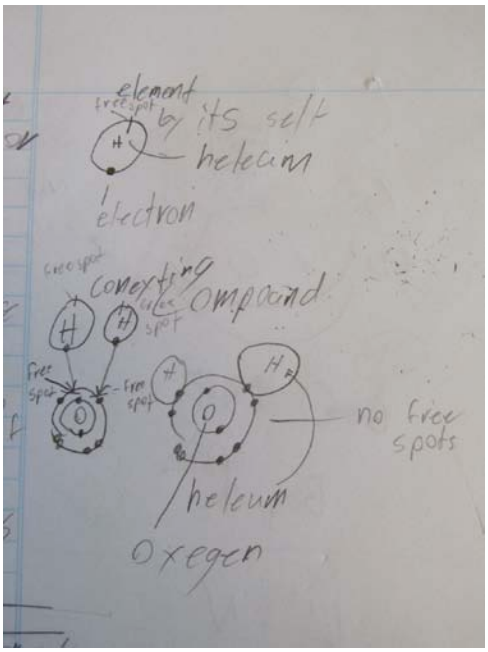
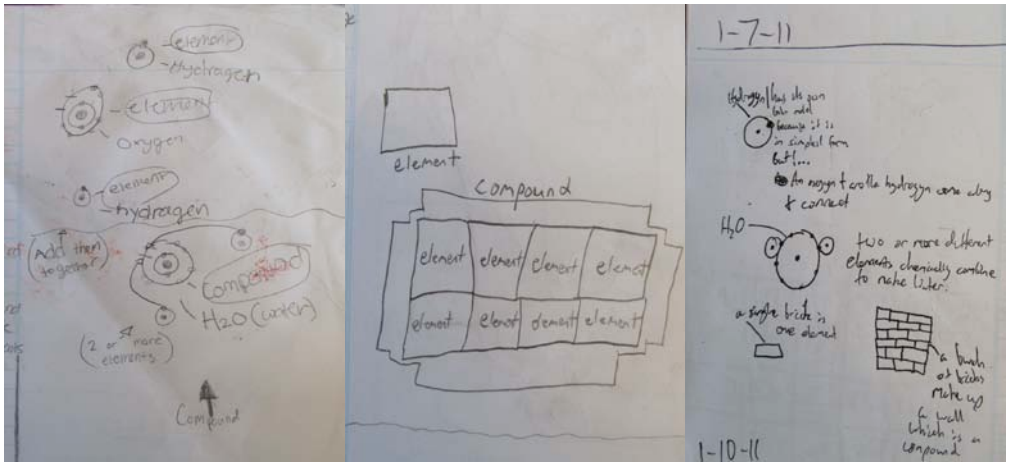


Figure 3. Students' use of Bohr Models in communicating science.

Before I taught this chapter, I recorded in my journal, "My biggest challenge to date…it will be difficult to come up with concepts to draw." I also recorded that it may help some students since chemistry will be "more abstract than vertebrates." This proved true when students came up with different ways to express how elements become compounds. I then noticed a pattern that I could record. In drawing more abstract scientific concepts such as in chemistry, students' drawings were categorized this way: standard, metaphorical, or a mix of both.



Figures 4, 5, 6. Standard, Metaphorical, and Mix Drawings of same lesson.

Metaphorical type of drawings did not appear in the vertebrate chapter. The metaphorical drawings included elements talking to each other, elements smiling at each other when bonding, elements falling in love or holding hands as in Figure *7.*

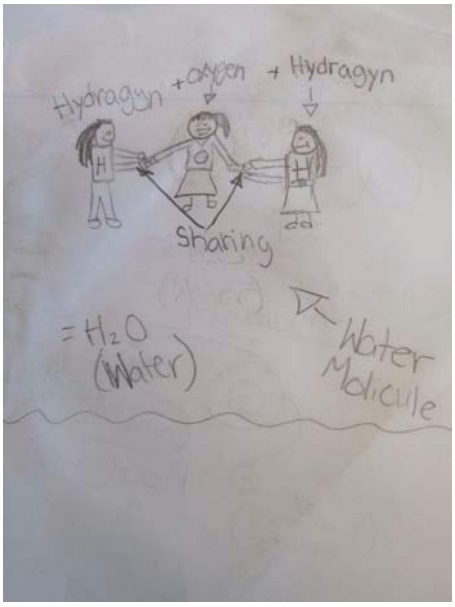


Figure 7. Students' Drawing of covalent bonding.

It was wonderful to see how students interpret more abstract scientific concepts. One student commented on the chemistry drawing by saying, “I feel I have freedom to draw the concept in my own way…interpret it my way.”

When I asked students if it helped to go over mistakes in their drawings, only one of the five mentioned it would not help. The other four mentioned, “Sometimes, like on the fish parts.” Another said, “Yes, don’t make the same mistake over again.” Even though these students disliked the treatment units at first, comments like these indicate a potential value to their learning. Other students in the class mentioned it was helpful to go over their mistakes as well saying, “Yes, if you didn’t get it, now you will know more about it and fix it.” Another said, “Yes, then I can see the picture correctly rather than incorrectly.” The class would review their drawings as part of our review day which was just prior to the final test. One girl mentioned, “Before the test…reviewing them—that does help.” In my journal I recorded, “In five minutes of observing students drawing a concept, I found it easier to pick up misconceptions than other classroom assessment techniques.”

The class’s average scores on their drawings were closely related to their final post assessment scores. I found thirteen out of twenty-one students’ drawing scores were within 10% of their post-test scores on Chapter 5, while on Chapter 9, the same scores,16

out of 21, and were within 10%.

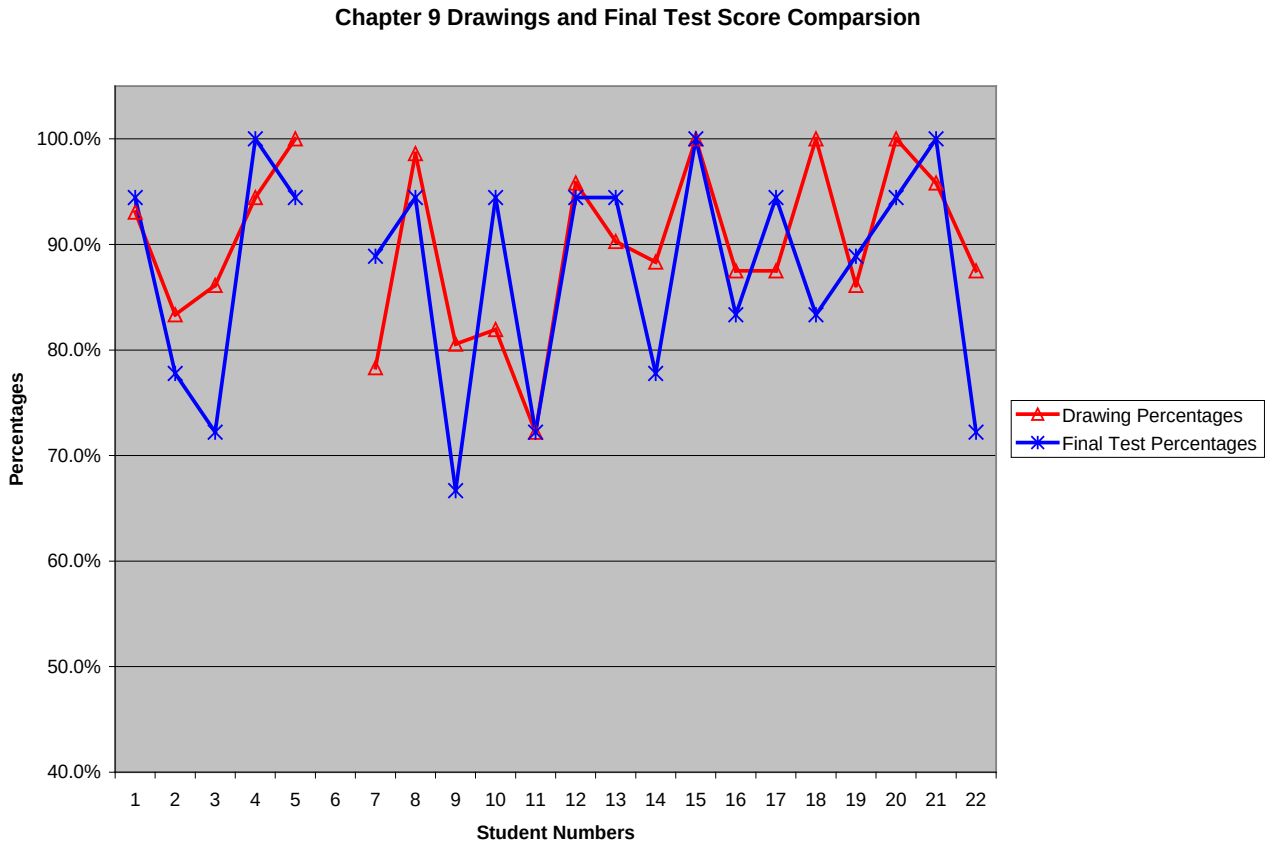


Figure 8. Comparison of Drawings and Final Test Percentages for Chapter 9 (*N*=21).

In looking at students # 9, 18, and 22 you notice they all have higher drawing scores than their final test scores. These students all enjoy art and excel in drawing. Student #22 as mentioned before is a tremendous artist, and so is student #9. These students lost few points in the category for drawing accuracy, and had few misconceptions. All three mentioned on their surveys that they are strong visual learners. Student # 18 score also has something to do with the fact she missed two of the six lessons during the treatment chapter, it is hard to make up this lesson by just having a student read the lesson from the book. I did not have her complete drawings, since she

did not receive the same prompts that the rest of the class received. She is normally an "A" honor roll student so her 83% final test score was surprising. Another issue could have been the total of 18 questions as compared to 30, 25, and 27 of the other tests. I know that many students missed one or two questions and the final test scores dropped considerably more than missing two on another test.

The students' attitudes toward drawing in science were evident when I told students that our next chapter was going to be a non-treatment chapter. Someone asked, "What does that mean?" I replied, "It basically means you won't be able to draw for this chapter." Their responses were interesting. I heard more sad groans than I expected. This means the class as a whole seems to enjoy the treatment chapters. There were a couple of students who pumped their fist as if to say, "Yes, no drawings!" Of course, some members of the group of five were glad not to draw. As the treatment chapters continued, student #16 responded, "Yes," when asked, "Overall would you recommend that teachers use drawings as part of class?" When he was asked why, he wrote, "It makes it easier for me."

The treatment units gained more and more popularity as time went on. Student surveys showed an increase from 53% to 91% in students who agreed or strongly agreed with the survey question: "I enjoyed using drawing as part of science class."

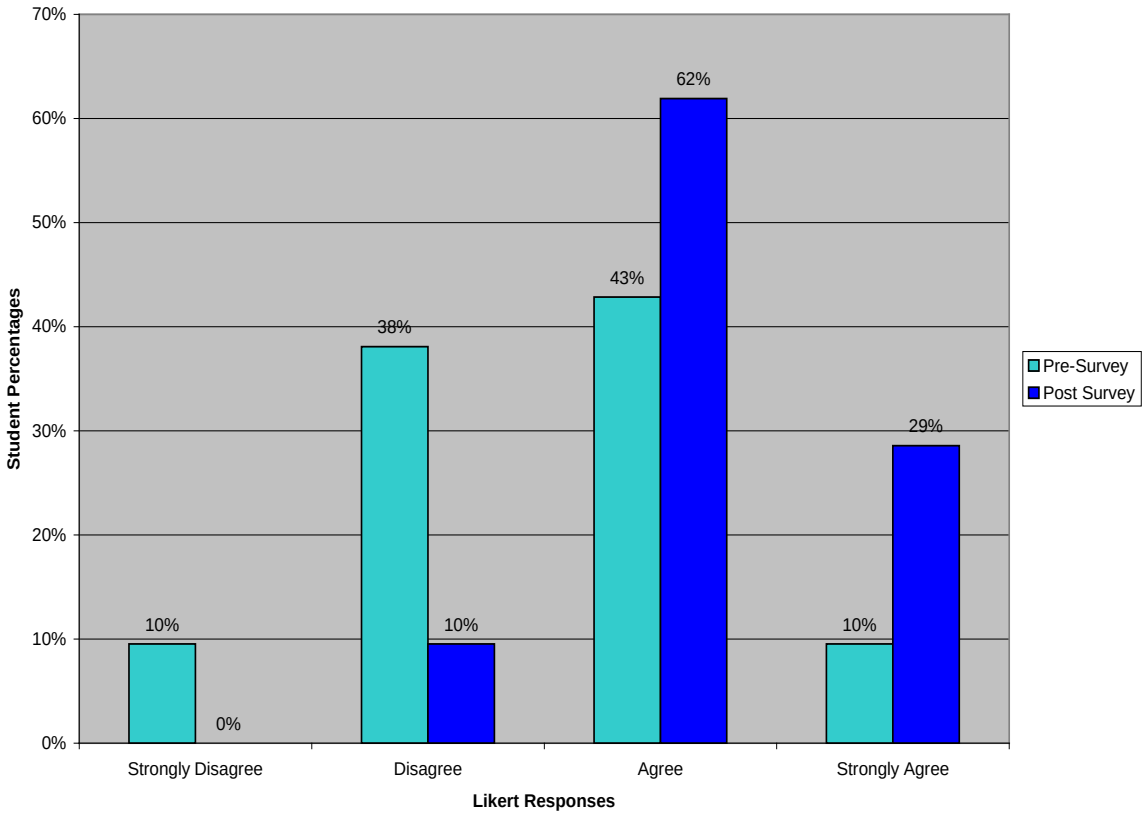


Figure 9. Responses before and after treatment to "I enjoyed using drawing as part of science class." (*N*=21)

The reason for this increase is different for each student. One student mentioned, "It does make me like science more…to not just read the book but to draw it!" Another said, "It's different. It's better and easier to understand when we draw versus when we don't." It was so advantageous for one student that when I asked on the final survey, "Which chapter, if any, would have been beneficial to be allowed to draw (in reference to non-treatment chapters)?" she responded, "I did draw a little, but not in my science notebook, so it was beneficial."

I was shocked. She did not follow directions. She was not supposed to draw in the non-treatment chapters, but I was smiling inside. Finally, another student wrote, “It’s easier. Not just for me but for a lot of people. It’s always there to look at.” This basically summarizes many of the students’ comments about my capstone project. In the end, three of the five students who did not like this project changed their attitudes towards it and found some value in it.

In looking back at my teaching journal I found five themes that I can use to grow as a teacher. The themes are comments that came up two or more times in my journal. The first was how much more visual I believed I needed to be, this was to give the students proper instructional prompts. For example, I wrote, “I used three different visuals today to give the students enough prompts to draw.” Without these, I thought students would struggle with the drawing of each concept I asked them to draw. The second theme was its use as a formative assessment. I found myself assessing the class as they drew and was impressed with the different drawings in expressing the same lesson. It usually took me five minutes or so to walk around the classroom once. I would go back to some areas or students if they were the first students I observed. The third theme was that I found it was harder to find visuals for chemistry; and I actually worried that I would not find proper drawing prompts. In the end, I found two or three visuals for each lesson. I have even ordered a cartoon science series for next year. The fourth theme was reaching out to staff and other professionals in helping me with my action research project. I recall advising other teachers to use surveys and actually interview students to learn more about their attitudes in their classrooms. The fifth theme was the temptation to use drawings in the non-treatment chapters. I actually recorded this up to five times in my

journal, writing for example that, “I wish I could have the students draw the three states of matter.” In the end, 19 out of 21 students agreed with me.

These five themes benefitted my students as well. I really came to appreciate the use of a teacher journal, and will continue to use one, as well as encourage its use to other staff members, student teachers, and the administration. One of the great benefits of keeping a teacher journal is that it helps you not to get complacent in your teaching.

INTERPRETATION AND CONCLUSION

In this research project, the students and I both benefited. The students were introduced to a new learning strategy—drawing. Using the science notebook in this way will aid students in the learning of science concepts in the future. Students were given freedom to draw the concepts the way they understand them, either standard style, metaphorical, or a mixture of both. Many students mentioned it was easier to draw in order to explain a scientific concept than write an explanation. The students and I were able to address mistakes in a positive manner before the summative assessment. I plan to continue to use drawings as part of my science instruction in order to benefit the students and myself. In this conclusion I will address my primary question followed by my three sub-questions.

1. What effects do students drawing in their science notebooks have on students’ understanding of science?

The students’ understanding of science was affected by how they chose to draw and also their focus during class. When drawing in their science notebooks after a passive

lesson, they were bringing together the *duel channels theory* mentioned by Paivio (1971). Drawing allowed students to retain concepts better when coded in a verbal and visual way. Therefore, many students mentioned that it was “easier” to draw than to write about science concepts. Students found it beneficial to understand how they learn best, which is termed metacognition. Looking at what they drew led me to how they best understood a concept. Some students learn best by metaphors, some by concrete or textbook illustrations, and some by a combination of both. Students who enjoy art, as well as students who do not, were affected the same. Test scores basically stayed consistent with the non-treatment chapters. Students scored their norm: 91 percent, 88 percent and 89 percent, 88 percent, respectively. (See treatment chapters.)

2. What impact do student notebooks have as a formative assessment tool?
3. What are the general mistakes that students make when drawing scientific concepts?

The results of the study also gave evidence that drawings are a tool of formative assessment. The students found it beneficial going over mistakes in general before summative tests (10 out of 12 students interviewed agreed). I was also able to quickly walk around and mention the positives and see the mistakes that students were making. Drawing also allowed students to use their drawings as a means of studying for the summative tests (19 out of 21 students surveyed agreed). The students made more conceptual mistakes during the more abstract chapter on chemistry than on a more concrete vertebrate chapter. This is due to the *dual channel effect* that states that people remember concrete items better than abstract ones. I also found many students leaving items unlabeled as opposed to mislabeled. Over 85% of labeling issues were unlabeled in

the general catalog of mistakes. Students who are really good at drawing did make fewer mistakes when it came to accuracy. The top six drawing students scored over 90% on accuracy.

4. How will students' views of drawing and science change based on the use of drawing in their science notebook?

Over the course of the research, I found that positive attitudes towards drawing in the science notebook greatly increased. Students who enjoyed treatment chapters rose by 48%. The students gradually warmed up to the idea of drawing as a means to explain what they know about science. This project has made me look at giving a choice on summative assessments—write or draw, or a combination of both. The key to this attitude change was making their drawings private, only for them—not public as in art class. I reminded them of the positives and quietly and privately mentioned their mistakes. The students saw value in their learning of science and certain scientific concepts when allowed to draw. One student was even compelled to draw in a non-treatment chapter.

5. How will students drawing in their notebooks affect me, the teacher?

This project has introduced me to a new way to evaluate my students as well as evaluate myself. I can easily see what I have effectively communicated and taught during my lesson by what students draw, as recorded in three teacher journal entries. I also found myself teaching in a more visual and animated way—beyond using video clips and the pictures in the textbook. In doing so, I found myself better prepared to teach the

treatment lessons. During the treatment chapters, I was always looking for new analogies or better visuals to incorporate into the lessons, as recorded in three teacher journal entries. I also found myself having a “fascination with education” in terms of research, talking with colleagues, and in understanding how all aspects of action research can be utilized to a teacher’s advantage, as recorded in four teacher journal entries. I made new professional connections with professors, fellow teachers, and authors as I reached out to learn more about my chosen research topic. Finally, I gained an overwhelming drive to positively affect learning in my classroom.

VALUE

Over the past three years I’ve been devoting part of my family’s summer to attending classes at Montana State University. Now seeing my coursework come to an end, I can now elaborate on what and how I have changed as a teacher and professional. In keeping things short and organized, I will be using the acronym I.D.E.A.L to explain these changes. This acronym is used by the Master’s of Education program at St. Mary’s University, Winona, Minnesota.

The first area is in instruction. In developing my capstone project and carrying it out, I was able to learn about using more visuals like cartooning in chemistry and drawing as a teacher, to help communicate proper scientific thinking to my students. I also found the use of analogies very powerful for a number of students. (Thirty percent of students drew analogies).

The second area was in discipline. It has changed in bringing the medium of drawing into the science classroom. Drawing allows students in science another way to

express their understanding of science. This is valuable to the discipline of science. Ninety percent of the students found this a productive way to express themselves after a passive lesson.

The third area is environment. The classroom environment was very quiet each time the students were required to draw in their science notebook (I recorded this three times in my journaling). The students also tracked the teacher more during lessons that required them to draw versus when they were not asked to draw. This led to students paying attention more and a better learning environment for all students. Students mentioned in the interview they felt they needed to pay more attention than normal because they did not know what I was going to ask them to draw. They needed to gather enough visual information to make a quality drawing; so paying attention to the drawing prompts was necessary. My classroom is a community of learners who respect their teacher and each other. This was enhanced by the teaming of science with art. We were learning together about how drawing affected the classroom environment, and that was motivating to the students.

The fourth area is assessment. In looking back on my capstone project, I really learned a lot about assessments. The first was formative assessment, which determines what students are learning during instruction. I never used formative assessments before this, and now I am promoting their use to other teachers on staff. I also learned a nice analogy: “formative assessments are like the chef tasting the soup before it is served to the customers,” which has helped me explain to others the role of formative assessments in the classroom. Student’s drawings are a quick way to gather information about the lesson that was taught. I can see who got it and who did not and follow up with

misconceptions. I also will now incorporate drawing into the summative assessments as well. This will allow students to communicate in a more productive way. (90% of students interviewed, mentioned drawing on final tests as being beneficial in the future).

The fifth and final area of change has been in leadership. In sharing my work with other staff members as they proofread my paper, they began to ask more educational questions. Our current fifth and eighth grade teachers already have started to incorporate drawings into their literature and geography lessons. I have heard our sixth grade teacher is also thinking about finding a master's program that includes action research as a component. I think that the more teachers discuss education and how students learn, the better our schools will become. In the past, I have had the privilege of speaking to teachers at a local teachers conference in New Ulm, Minnesota. I now look forward to presenting my research at the same conference as well as to current staff members, parents, and congregation members.

In this final section, I want to discuss things that I would suggest, and questions I still have. If another teacher decides to use the techniques I discussed in this capstone project I would advise them to be positive with students. It also will help the students to use a notebook that has space provided for drawings. It is important to give students 5-8 minutes to draw at the end of the lesson, while the teacher walks around and picks out any misconceptions. Try not to hover too long over one student; they may start to think something is wrong. In the future, I will let students color their drawings as some concepts need color to help express correct understanding (e.g., male duck vs. female duck). This past year, I applied my treatment ideas to my 5^{th}, 6^{th} and 8^{th} grade science

classes in areas of review, exit tickets, and in the middle of a lesson. These were all productive areas where I will continue to use drawings.

I also still have some questions that my project did not answer. The first one is how could I use drawings in lab? This is traditionally where teachers use drawings. I wonder how my students would respond to drawing after or during a lab? How will coloring their drawings affect the students? Will it be too much for some students? How will having students draw on summative assessments affect them? Finally, can students be asked to do a series of drawings to explain a whole chapter?

In all, this has been a valuable learning experience for me as a teacher and a professional. The key in action research is to base conclusions on scientific research rather then opinions and fads. I believe I have now come closer to becoming the I.D.E.A.L. teacher that my school and my students deserve.

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APPENDICES

APPENDIX A

PRE-TREATMENT ATTITUDE SURVEY

Appendix A

Grade 7
Student Survey
10/1/10
Science

Name: _____
Date: _____

Please complete the survey by reading each statement and circling how much you agree with the statement.

1. I enjoy attending school at King of Grace.

Strongly Disagree Disagree Agree Strongly Agree

2. I am on the honor roll 3 or more times each year.

Strongly Disagree Disagree Agree Strongly Agree

3. I enjoy art class

Strongly Disagree Disagree Agree Strongly Agree

What is it about art class that led you to respond this way?

4. I like learning how to draw in art class.

Strongly Disagree Disagree Agree Strongly Agree

5. I am comfortable with assignments that require me to draw.

Strongly Disagree Disagree Agree Strongly Agree

Why did you respond this way?

6. I often draw or doodle pictures just for fun.

Strongly Disagree Disagree Agree Strongly Agree

7. I enjoy science as a subject.

Strongly Disagree Disagree Agree Strongly Agree

8. I am good at science.

Strongly Disagree Disagree Agree Strongly Agree

9. I enjoy drawing in my science notebook.

Strongly Disagree Disagree Agree Strongly Agree

10. I have a favorite art project.

Strongly Disagree Disagree Agree Strongly Agree

What was it? Why?

11. I remember science concepts well by writing them out as notes.

Strongly Disagree Disagree Agree Strongly Agree

12. I remember science concepts well by seeing them, picture or video.

Strongly Disagree Disagree Agree Strongly Agree

Why did you respond this way?

13. I remember science concepts well by hearing them.

Strongly Disagree Disagree Agree Strongly Agree

14. I remember science concepts well by talking about them.

Strongly Disagree Disagree Agree Strongly Agree

15. I do not like drawing at all.

Strongly Disagree Disagree Agree Strongly Agree

APPENDIX B

DRAWING RUBRIC

APPENDIX B

Scientific Drawings Rubric: Science Notebook Drawings

CATEGORY		4	3	2	1
Scientific Details Present		All essential scientific details have been added.	Almost all essential scientific details (at least 85%) have been added.	Almost all essential scientific details (at least 80%) have been added.	Fewer than 75% of the essential scientific details are present.
Labels		Every item that needs to be identified has a label. It is clear which label goes with which structure.	Almost all items (90%) that need to be identified have labels. It is clear which label goes with which structure.	Most items (75-89%) that need to be identified have labels. It is clear which label goes with which structure.	Less than 75% of the items that need to be identified have labels OR it is not clear which label goes with item.
Accuracy		95% or more of the assigned structures are drawn accurately and are recognizable.	94-85% of the assigned structures are drawn accurately and are recognizable.	85-70% of the assigned structures are drawn accurately and are recognizable.	Less than 70% of the assigned structures are drawn accurately.

APPENDIX C

SEMI-STRUCTURED INTERVIEW QUESTIONS

Appendix C

Semi-Structured Interview Questions

1. What is your favorite subject in school?
   Probe: Why is it?

2. Do you like to draw?
   Probe: why or why not?

3. Can you remember your favorite science class, and why did you like it?

4. Have you used drawings in other areas of school? If so, when, and did it help you?

5. When doing drawings, what do you like the best? What do you like the least?

6. If drawings are part of the learning of a concept, should it also be included on an assessment (test)? In what ways could I incorporate this into an assessment (test)?

7. Does your ability to draw affect your view on the science notebook idea? How and why?

8. How much time is necessary to complete a science drawing?

9. Would it help if you knew what I wanted you to draw before the end of the lesson?
   Probe: Why or why not?

10. When you made mistakes in your drawings was it helpful to go over them?
    Probe: Why or why not?

11. If you like art and drawing does drawing science concepts increase your attitude towards science?
    Probe: In what ways does it increase your attitude towards science?

12. What scientific concepts may be harder to draw for you, which ones are easier?
Probes: What about them makes them harder? Why are they easier?

APPENDIX D

FINAL SURVEY
ADDITIONAL QUESTIONS 16-19

** These questions were added to the original survey (Appendix A), for the final survey.*

16. There are times that I wanted to draw after a science lesson but wasn't able to during non-treatment chapters.

Strongly Disagree Disagree Agree Strongly Agree

17. It was easier to draw in the chapter that dealt with:

Animals (chap 5) or Chemistry (chap 9) or None were easier

18. Which chapter if any would have been beneficial to be allowed to draw?

Properties or Matter (chap 7) or Heat (chap 12) or None

19. Overall would you recommend that teachers use drawings as part of class?

Yes No

Why? or Why not?