IMPLEMENTING INTERACTIVE SCIENCE NOTEBOOKS INTO 6TH GRADE CLASSROOMS

by

Renee Marie Lauterbach

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2016

DEDICATION

This paper is dedicated to my father and mother, who have always had faith in me and have pushed me to believe in myself. They have taught me the importance of an education and how to continually help others. None of this would have been possible without their encouragement, support, and love. Thank you both for all of the knowledge and opportunities you have provided me with. I truly am blessed and lucky to have you as my parents.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The implementation of Interactive Science Notebooks in middle school science classes was the focus of this research project. Two groups of sixth grade students were used to conduct the research. The unit covered was about the dynamic earth. The treatment class was taught using Interactive Science Notebooks, while the non-treatment class was taught using a more traditional lecture and note format. Results showed that learning, engagement, thinking, and communication were effected by the use of these notebooks. Through student interviews, students also expressed an enjoyment of the use of Interactive Science Notebooks.

INTRODUCTION AND BACKGROUND

At the time of this project, I taught at Hmong American Peace Academy (HAPA) in Milwaukee, Wisconsin. HAPA was a charter that was a college and preparatory school, which had kindergarten through twelfth grade. There were over 10,000 Hmong living in Milwaukee and HAPA was the only school that specialized to meet the needs of this large, growing Hmong community in the city. Almost 99% of students were Hmong. This was the twelfth year that the school had been running and each year the enrollment had increased. At the time, it had a student body of 1,407 students. The school was located at two different sites because the school was not large enough to hold everyone. It was a future goal to raise money to expand and renovate site one, so all students would be able to attend. The ultimate objectives we were striving to achieve at HAPA included: maintaining rigorous academics, preparing students for high school and college, and preserving the cultural identity of the Hmong.

I typically taught the second or third generation of Hmong families that lived in Milwaukee. The Hmong population had come from Laos, Thailand, and Vietnam. Hmong people were recruited from those areas during the 1960s and 1970s to help Americans fight the Vietnam War ("The Hmong Culture," 2015). However, after the United States evacuated the area, the Hmong people came under attack and had to flee to save their lives. Some were able to come to the United States right away and these were known as the first generation Hmong ("The Hmong Culture," 2015). Other Hmong fled to Thailand and ended up living in refugee camps until they could come to America. As time passes, there are still more Hmong families coming to the United States and we see the Hmong population growing immensely here ("The Hmong Culture," 2015).

The majority of Hmong students in my classes lived in the poverty-stricken and rough neighborhoods in the northern and southern parts of Milwaukee. My students' parents were extremely busy, typically working two jobs each. The communication between parent and child for many families was minimal. This was due to the fact that many were not able to spend a lot of time together. Parents worked long hours, leaving their eldest children responsible for taking care of younger siblings, so homework did not end up being a top priority. There also was a disconnect found between the generations because the children spoke primarily English versus Hmong. Even though most of the children were still considered English Language Learners (ELL) or English as a Second Language (ESL) students, they were more Hmong-American than their elders because they were blending in and adapting to living in America. Some generations spoke "Hmonglish," which is a slur referring to a combination of both languages. The reason they spoke this way was because many words in English did not directly translate into the Hmong language.

Although education is highly valued in the Hmong culture, there was insufficient support and follow through at home. Parents were often incapable of helping their children with any of their homework because of the language barrier. Hmong is also a fairly new written language and even many Hmong parents did not know how to read or write in Hmong. The Hmong people in the past simply were not taught these type of skills because for generations they were farmers. This challenge of reading and writing is continually seen through all the grade levels. Several Hmong parents also expect that simply because their child knows English, they should and will become doctors.

Unfortunately, this is not a realistic option for all, but it can become more realistic as Hmong children become stronger and higher achieving students.

I conducted this project during my second year working at the Hmong American Peace Academy. Feeling extremely passionate about the need to change the way my students interact with science content for them to be successful in the future drove me to follow through with this project. I was the only earth science teacher at my school teaching four classes of sixth grade earth science and one literature class, with roughly 23 students in each class. Class periods lasted 50 minutes. To help my students better interact with each other, the classroom was divided into five different science teams, with no more than six students per team. Within each lesson, I specifically focused on content and language objectives. The emphasis of vocabulary was also extremely needed and beneficial for the students.

I was concerned about the quality of how I was engaging my students. Students seemed compliant rather than excited to complete activities. I wanted my students to gain confidence in their scientific abilities. For two years I had observed a disinterest in studying science outside of the classroom. Students scored extremely low on quizzes and tests. It seemed that they were not making strong connections with the material and were misunderstanding how to apply learned information. They also failed to share their ideas, thoughts, and answers with me, a partner, or in their science teams. Students were very shy and hesitant to participate because not only can science content be complicated but the language barrier added an extra challenge.

I wanted to determine if there was a direct correlation between student engagement and communication with science notebooks. I wondered if learning

experiences such as activities, lectures, and labs would be improved with the implementation of an Interactive Science Notebook (ISN) techniques. ISNs are more involved than traditional science notebooks in that there are specific processes in which the notebooks must be used.

The notebooks also provide many starting points for students to develop more analytical and evidence based discussion skills. My students in particular were very quiet because they have been taught to respect their elders. Listening is more emphasized than sharing their opinions or asking questions in their culture. This is why I felt that communicating with notebooks would be extremely beneficial for my entire student population. Although these notebooks could possibly increase the academic discussions that take place between parent and student, this was not a primary goal of mine. I was focused on communication that I could personally observe inside the classroom.

The shift to more note-centered instructional practices and toward a curriculum that focuses on science content through the scientific method led to the following focus question: *What is the effect of implementing Interactive Science Notebooks (ISN) on student learning in middle school science classes?* My project considered three sub questions:

- How is engagement in science affected by ISNs?
- What is the effect of using ISNs on students' thinking?
- What impact does the ISN have on student-to-student interaction and communication?

CONCEPTUAL FRAMEWORK

ISNs are "a compilation of entries that provide a partial record of the instructional experiences a student had in her or his classroom for a certain period of time" (Hargrove & Nesbit, 2003, p.1). Science notebooks include structured writing that focuses on the scientific method, and the use of science process skills. Students label and date the pages and attach any handouts, with all student work put in chronological order (Chesbro, 2006). The ISNs are broken down into a left (output) side and a right (input) side.

The right side of the notebook is teacher-initiated, directed, and objective based (Crippen, 2009), and it may contain things like notes from class, videos, readings, activities, and lab data (Chesbro, 2006). The left side is where students personally connect with the information that is on the right side of their notebook (Chesbro, 2006). The left side of the notebook has an "in and out" activity. The activities include things such as drawings, reflections, and worksheets. These are teacher-initiated, student-directed, and subjective (Crippen, 2009). This is the main difference between ISNs and typical science notebooks with which most educators are familiar. The word interactive refers to how the science notebooks can be used (Marcarelli, 2010). By using a notebook this way, students are modeling the most important and enduring functions of scientists in all disciplines, which is to record and interpret data (Young, 2003).

The ISN can be an effective instrument to develop and reinforce science and academic language (Marcarelli, 2010). It forces students to develop connections between background knowledge they have and new information they learn. It also allows students to revise their ideas and strengthen their understanding of content. Notebooks are considered thinking tools because they allow students to construct their own conceptual

understandings (Gilber & Kotelman, 2005). Students show their understanding of the content through the output side and as Chesbro found, are able to make deep and resonating connections (2006). When used daily, these notebooks can promote learning and have been found to be successful because they use both left and right hemispheres of the brain to categorize, sort, and implement new knowledge in a creative manner (Young, 2003). Summative activities that encourage higher-order thinking are considered an output activity and are found on the left side of the notebook (Chesbro, 2006). Students may use color, which helps the brain learn (Young, 2003). Students' notebooks represent all the learning that took place throughout the year (Chesbro, 2006). This is essential to create a culture of thinking (Perkins, 2008).

A truly engaged student is one who is seeking to develop his or her own knowledge and is trying to relate that new information to their own experiences. This is different from the disengaged learner who just shows up to class, merely memorizes facts, and attempts to simply pass the course (Exeter et al., 2010). Students who achieve conceptual understanding after active learning maintain that knowledge for a much longer period of time compared to students who simply memorize the information (Yuruk, 2009). Ideally, all students should be engaged in the classroom.

Using this type of notebook requires active engagement with the course concepts (Crippen, 2009). The work that is completed in ISNs has a purpose, and students are investigating questions they have come up with and in which they are truly invested (Hargrove & Nesbit, 2003). Students are engaged because they have an outlet to be innovative (Crippen, 2009). Each notebook can become an expression of each student's effort and creativity; students can demonstrate ownership and pride in their work

(Crippen, 2009). Students become primarily involved in their own learning when ISNs are implemented (Hargrove & Nesbit, 2003). This can lead to increased feelings of empowerment and student confidence through the completion of notebook activities (Crippen, 2009).

The ISN helps to improve writing across the curriculum, metacognition strategies, inquiry-based science instruction, and makes learning personalized (Chesbro, 2006). Students connect their experiences with new material and learn to gain knowledge in ways that aid in creating life-long learners (Young, 2003). These notebooks also allow for science educators to implement constructivist-teaching strategies, while differentiating instruction, addressing standards, and promoting literacy development (Chesbro, 2006).

Students who complete conceptual writing in their notebooks with claim and evidence statements improve in their post-tests over students who do not (Hargrove & Nesbit, 2003). Students apply their knowledge when they complete graphic organizers, flow charts, word webs, Venn diagrams, pictures, concept maps, mind maps, brain dumps, and summaries (Chesbro, 2006). Essentially, students create a representation of their understanding that demonstrates higher levels of learning (Crippen, 2009). When educators help to foster an environment where thinking is made visible, students benefit (Perkins, 2008). Students were able to make tangible connections to past experiences and knowledge. The notebooks also provided a structure and support system for differentiated learning that benefited struggling students (Marcarelli, 2010).

One of the main benefits of using an ISN is increasing communication between stakeholders including students, teachers, and parents (Marcarelli, 2010). Parents can read their child's notebook and ask them questions about what they are learning in science. It also is a way for the student to communicate their understanding of science concepts to their teacher. With improved literacy, students are able to communicate in a variety of forms. Students are able to share their outcome sentences like: *I learned, I am surprised, I wonder, I now understand, I rediscovered, I like, I don't like, The important thing about,* and any other thoughts or ideas they had about the material (Chesbro, 2006). Notebooks also enhance literacy skills and allow students to use different forms of expository, procedural, narrative, descriptive writing, and labeling, which provide a picture of students' thinking (Gilbert & Kotelman, 2005).

The science notebook focuses on tasks like researching, evaluating, analyzing and collaboration (Hargrove & Nesbit, 2003). When students organize and clarify their thoughts they can understand new ideas much better (Young, 2003). Engaging in true tasks allows the student to collaborate with other classmates, to connect with their work and to compare hypotheses and conclusions (Hargrove & Nesbit, 2003). Students' communication skills are improved when they read others' notebooks or when they are discussing in small groups what they put in their notebook (Hargrove & Nesbit, 2003).

The ability to apply science in various ways and to express one's understanding of content through different outlets are invaluable tools that will aid students throughout their lives. The use of science notebooks as middle schoolers, could help further prepare students for science in high school and college. Engagement and modeling science

practices can lead to an interest in science. ISNs have the potential to even encourage students in pursuing a career in science.

METHODOLOGY

This project was conducted over six weeks, during the third quarter of the 2015-2016 academic year. Third quarter tends to be when most students struggle with content and most behavioral issues occur. My primary question of study was: *What is the effect of implementing Interactive Science Notebooks on student learning in middle school science classes?* In order to determine this, I taught Science Fusion curriculum with the use of ISNs. For the previous quarters of the school year, I typically taught using packets of notes or PowerPoint presentations.

My treatment class, with which I conducted this research project, was my third hour group of sixth graders. There were a total of 21 students in the class, and there were 9 boys and 12 girls. I chose this class in particular because they were one of my lowest performing groups on assessments. I implemented ISNs for only that one class of sixth graders, while the other three classes received normal lecture/note format style instruction. I taught the Dynamic Earth unit, during this action research project. The chapters focused on earth's surface, earth's history, minerals, and rocks.

I began by providing all students in the treatment class with composition notebooks to use as their ISN. I taught them how to set their notebook up and how to label their Table of Contents correctly. I then gave them all an Interactive Notebook Thinking Process sheet from the *Teaching Science With Interactive Notebooks* book (Marcarelli, 2010). This page provided an explanation of the higher-level thinking that was going to take place on the left side of the notebook, while I facilitated their learning

on the right side of the notebook. Next I provided the students with an ISN rubric, so the students were aware of the quality of work that was expected of them. Students were told that their ISN would be collected at the end of each chapter and would be taken as an assessment grade.

Changing how students acquired and recorded their information was very important to my study. Instead of printing off the notes for the students like I did with the non-treatment group, students in the treatment group were given information in a graphic organizer format and glued that page into their notebooks. Students were required to interact with the material and display their knowledge of the content by applying it in a variety of formats, such as foldables, category sorting, poetry, sentence stems, comic strips, Venn diagrams, and writing prompts.

I used nine data collection tools to gather information on the effect of implementing ISNs and their impact on student learning. These included: *Pre and Post Unit Student Engagement Surveys, Pre and Post Unit Teacher Checklist for Student Engagement*, *Student Perception of Engagement Interviews*, *Pre and Post Opinion Surveys, Summative Assessment Scores versus ISN scores*, *Pre and Post Unit Assessment Scores*, *Pre and Post Student Communication Surveys*, *Pre and Post Unit Teacher Checklist for Communication*, and *Student Communication Interviews*. This treatment period ran from January 2016 to March 2016. Data were collected in three phases: Pre Unit, During the Unit, and Post Unit (Table 1).

Table 1
Data Triangulation Matrix

Primary Question:	Data Source 1	Data Source 2	Data Source 3
1. What does the effect of implementing Interactive Science Notebooks have on student learning in middle school science classes?	Pre and Post Student Opinion Surveys	Summative Assessment Scores and ISN Scores	Pre and Post Unit Assessments (tests, quizzes)
Secondary Questions:			
2. How is engagement in science affected by ISNs?	Pre and Post Unit Teacher Checklist for Student Engagement	Pre and Post Unit Student Engagement Surveys	Pre and Post Unit Student Perception of Engagement Interviews
3. What is the effect of using ISNs on students' thinking?	Pre and Post Student Opinion Surveys	Summative Assessment Scores and ISN Scores	Pre and Post Unit Assessments (tests, quizzes)
4. What impact does the ISN have on student-to-student interaction and communication?	Pre and Post Unit Teacher Checklist for Student Communication	Pre and Post Unit Student Communication Surveys	Pre and Post Unit Student Perception of Communication Interviews

The Pre and Post Unit Student Engagement Surveys were given to all students in the treatment class before and after the unit (Appendix A). This helped me to address the secondary question: *How is engagement in science affected by ISN?* The survey allowed the students to communicate which classroom activities interested and engaged them the most, and helped me to understand how to make the ISN as engaging as possible.

The Pre and Post Unit Teacher Checklist for Student Engagement (Appendix B) also helped me address my student engagement sub-question. I completed this checklist with the treatment class before and after the treatment chapters. Using this checklist allowed me to determine what activities were engaging my students. I focused on typical

signs of an engaged learner and checked them off based on whether the engagement was not observed, occasionally observed, commonly observed, and always observed. *Not observed* meant that the student did not engage in the activity or did not participate. This was given a one on the checklist. *Occasionally observed*, recorded as a two on the checklist, meant that the student engaged at a slightly below normal level, what typical participation looks like on a daily basis. The student did not ask any questions when confused and did not use all their resources to complete a task. *Commonly observed* meant that the student engaged at a normal level, but did not stand out above other students and did what is required of him or her. *Always observed* meant that the student engaged in all activities and even at times went above and beyond what was asked of them. These were recorded as a three or a four, respectively. I decided to observe five students for the checklist on student engagement from the treatment class who had the highest and lowest levels of engagement from the previous surveys.

I conducted Student Perception of Engagement Interviews (Appendix C) at the beginning and end of the third quarter. I modified the topics in the Student Engagement Survey to create interview questions that led to further discussion and explanation of student levels of engagement. I decided to interview the same five students I had observed for the checklist on student engagement.

I gave Pre and Post Unit Opinion Surveys (Appendix D) to all of my students in the treatment class. This survey addressed the second secondary question: *What is the effect of using ISN on students' thinking?* The survey questions provided information about how students study and use their notes to prepare for assessments in science and gave me some insight into how my students think and learn from the resources they have

available to them. Students were able to convey which resources help them perform better on specific assessments. In addition, I gained further information on how I would move forward with the implementation of the ISN.

The next data collection tool used was summative assessment scores versus ISN rubric scores (Appendix E) and was taken from all students in the treatment class after the unit. This addressed the secondary question: *What is the effect of using ISN on students' thinking?* Ideally, students who earned a high ISN score would also earn a high summative test score and vice-versa. I hoped to see an increase in the application and learning of science content through ISN. I measured the change in each of these factors from quarter two to the end of the research project in quarter three, and calculated normalized gain (Hake, 1998).

Examination of normalized average gain of non-treatment and treatment groups of Pre Unit and Post Unit assessment scores (tests, quizzes) helped to determine if the use of the ISN helped to improve content knowledge (Appendix F). This addressed the second secondary question of the effect of ISN on students' thinking. This allowed me to determine if students perform better on specific types of assessments when learning science material through an ISN.

In order to address: *What impact does the ISN make on improving the way students communicate,* students from the treatment class completed a Pre and Post Unit Communication Survey (Appendix G). Students answered questions regarding their confidence in communication. I was able to determine changes to students' opinions of how appropriately and clearly they could express their understanding or knowledge of science content through either speaking or writing.

I took the same topics from the Student Communication Survey and modified them to lead to further discussion and explanation of student level of communication for individual interviews (Appendix H). I interviewed a total of five students from the treatment class, three who had the highest and two who had the lowest levels of communication from the previous surveys. I felt that these particular students would give me more insight into what motivates or aids students to speak, write, and communicate more clearly in science. I focused particularly on what challenges students face and what I could do to help them. These interviews aided me in obtaining more information on the effect of ISN on student communication.

I used Pre and Post Unit Teacher Checklists for Communication (Appendix I) for the subset of students who were interviewed. I specifically recorded their use of correct science terminology when they were asking and answering questions. Then I recorded how well these students communicated through their speech with partners, in their writing in their ISN, and on their assessments. I hoped to see that with the implementation of the notebooks, my students would incorporate higher levels of science terminology in the speech and writings.

A summary of the instruments used during this project can be seen above in the Data Triangulation Matrix (Table 1). 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.

DATA ANALYSIS

A Pre and Post Unit Teacher Checklist for Student Engagement helped me to address my first secondary question, which was: *How is engagement in science affected by ISN*? I completed this checklist on five students in the treatment class before and after the treatment chapters. Using this checklist allowed me to determine what activities were engaging my students. I focused on five typical signs of an engaged learner and checked them off based on whether the engagement was not observed, occasionally observed, commonly observed, and usually observed. There were four out of five students who improved in the following categories: being able to demonstrate interest and curiosity in the inquiry and asking on-topic questions and responding appropriately to questions (Table 2). Only two out of the five students improved in the ability to self-monitor their own learning by staying on task, the ability to make connections to self, text, and life experiences, and the ability to engage successfully with a partner or in a small group.

Table 2.
Pre and Post Unit Student Engagement Checklist Observations

AVG	Question 1: Demonstrates interest and curiosity in the inquiry	Question 2: Asks on-topic questions and responds appropriately to questions	Question 3: Is able to self-monitor their own learning by staying on task	Question 4: Makes connections to self, text, and life experiences	Question 5: Engages successfully with a partner or in a small group
Pre Unit	2	2.6	2.6	1.8	2.8
Post Unit	2.8	3.6	3.2	2.4	3.4

Note. Average Pre and Post Unit ratings, (*N*=5).

The Pre and Post Unit Student Engagement Surveys were given to all of my students in the treatment class. This helped me to address my first secondary question, which was: *How is engagement in science affected by ISN?* The survey allowed the

students to communicate which classroom activities interested and engaged them the most. The Engagement Survey data can be found in Appendix J. With the use of ISNs, data indicated a 19% increase in engagement during class discussions, a 10% gain in engagement during individual readings and as presentations, and a 14% gain in engagement when involved in teamwork. From Pre Unit to Post Unit there was a decrease in engagement during teacher lectures, projects, partner activities, taking notes, and computer work (each at a loss of 5%). In addition, students reported a 10% decrease in engagement during lab work. This was not due to the use of the ISN though, responses indicated that this was because of the group aspect during lab work. A student explained, "I get more distracted during labs because of certain team members."

The Student Perception of Engagement Interviews helped me to address: *How engagement in science is affected by ISN*. I took the same topics from the Student Engagement Survey and modified them to create interview questions that led to further discussion and explanation of students' levels of engagement. I interviewed five students from the treatment class who had the highest and lowest levels of engagement from the previous surveys. I felt that these particular students would give me detailed insight onto what sparks interest in activities and topics and makes my students more involved in their own learning. Table 3 shows that the students interviewed felt that their engagement in science improved with the use of ISNs.

Table 3.
Post Unit Engagement Interview Responses

Engagement Questions	No	Yes
1) Do interactive science notebooks help make lectures from teachers more interesting?	20%	80%
2) Do interactive science notebooks help you get more involved in class discussions?	40%	60%
3) Do interactive science notebooks help you become more interested in reading science material?	40%	60%
4) Do interactive science notebooks help you stay engaged and on task during teamwork time?	40%	60%
5) Do interactive science notebooks help to make taking notes more enjoyable?	20%	80%
6) Do interactive science notebooks help you complete lab work and make you more excited for a science lesson?	0%	100%
7) Do interactive science notebooks help you become more engaged when you work alone and/or with a partner?	40%	60%

Note. (*N*=5).

During the interviews, students answered yes and no questions but also further explained their reasoning behind them. Data provided evidence that students felt it made lectures and reading science material more interesting. One student stated "Yes because it tells you how or what it is for." "The notebooks make[s] it easier for us to understand," another said. The data revealed the ISN helped students get a little more involved in class discussion. Other students said "Nobody might have the same answers, so I can be the only one saying the answer my way" and "They help me understand the topic and lesson." The majority of students felt ISNs aided them in completing their lab work. A student explained it as, "It help[ed] me complete the lab easier and then looking at the results is interesting." Students felt they were more engaged during teamwork, partner, and alone time with their ISNs. "It helps me stay on task," and "I can see other peoples answers and then I can form a new answer with others ideas," students stated. Responses also indicated that it made taking notes more

enjoyable when they had their ISN, for example one student said “The ISN helps taking notes more fun because we have fun activities along with it.”

The Pre and Post Unit Opinion Survey was given to the treatment class. This survey addressed the secondary question: *What is the effect of using ISN on students’ thinking and learning.* Survey responses indicated a common trend in which students used sources other than their textbook to study for upcoming quizzes and tests during the treatment period (Appendix K). Eighty-one percent of students used not only their book but notes from their ISNs, and other available resources like the internet or a friend, to help them study for upcoming quizzes. However, only 71% did this to prepare for upcoming tests. In addition, 52% of students felt their science notes helped them earn higher grades on their homework. Unfortunately, only 38% of students felt it helped them earn higher grades on their quizzes. This was ironic because every quiz or test question I created was taken from information that was in their ISN. I even allowed the students to use their ISN when taking their assessments. Despite students feeling like the ISN did not help them very much on assessments, at least 67% of students believed they were more aware about what they need to do in order to do well on a science test. Also, the number of students who felt they were good at preparing for science assessments, and earning a high grade on them, did not change throughout the treatment.

Summative assessment scores versus ISN rubric scores were taken from all of my students in the treatment and non-treatment class before and after the unit. This addressed the secondary question: *What is the effect of using ISN on students’ thinking and learning?* I hoped to see an increase in the application and learning of science content through ISN. Students who earned a high ISN score would also earn a high summative

test score and vice-versa. The strength of this relationship between these two variables would be determined by the number of points that fall on or near the line of regression. Figures 1 and 2 show the direct relationship between the ISN score and summative tests scores at the end of the first and second treatment periods. Generally, if students earned high scores on their ISNs then they also earned high assessment scores. Both figures indicated a slightly positive line of regression, without the removal of outliers. The lone low outlier weakened the correlation between tests scores and ISN scores. This student was absent for a long period of time, so I attribute his lower score to that.

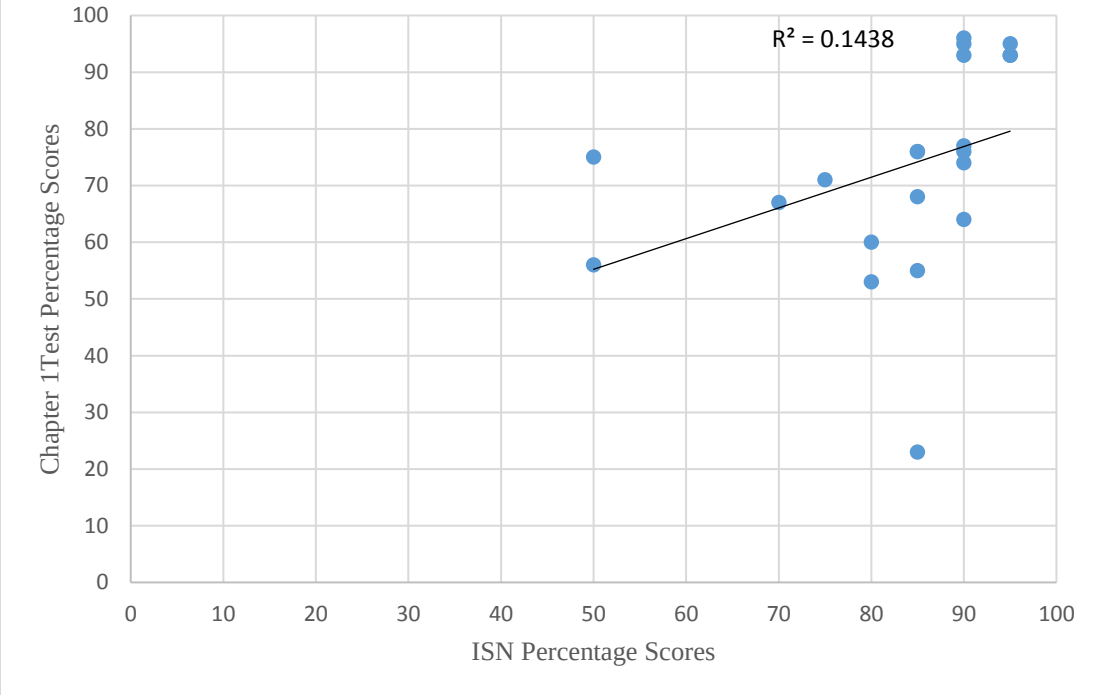

Figure 1. Relationship between the summative tests scores and the ISN scores during Chapter 1 unit, (*N*=21).

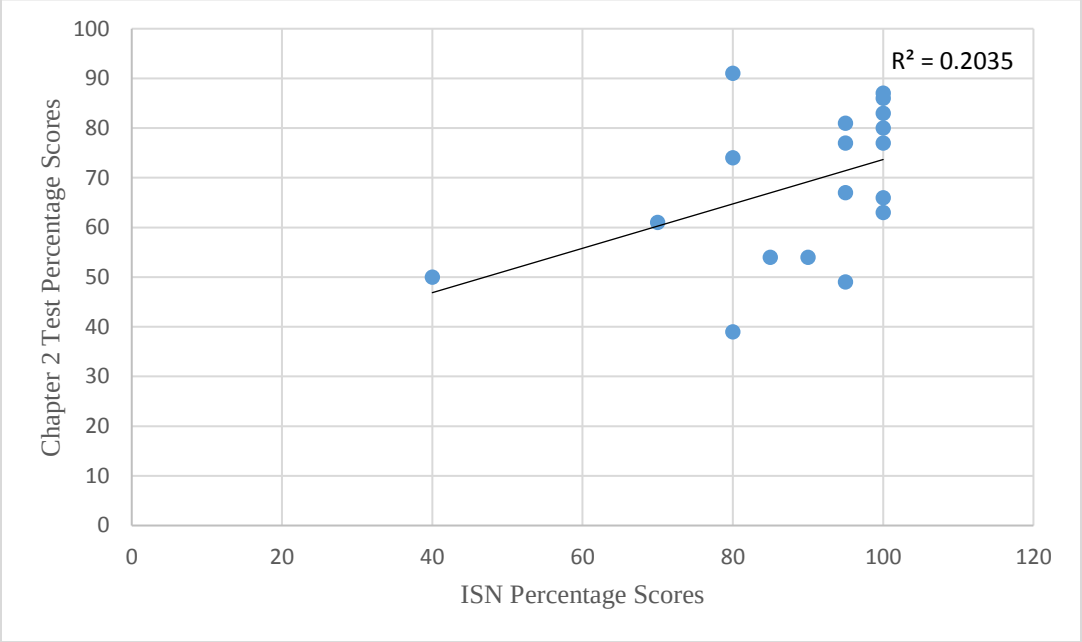

Figure 2. Relationship between the summative tests scores and the ISN scores during Chapter 2 unit, (*N*=21).

Data collected from Pre and Post Unit assessments were used to determine if the use of ISNs helped performance on content assessments. This helped to address the secondary question: *What is the effect of using ISN on students' thinking and learning*? This allowed me to determine if students perform better on all types of assessments when learning science material through an ISN. The non-treatment class had a normalized average gain of -0.087 for tests and -0.372 for quizzes. I believe this negative value was due to the assessments being more challenging because I was asking students to critically think and respond versus traditional multiple-choice tests. However, the treatment group had a positive normalized average gain but it was minimal with 0.136 for tests and 0.022 for quizzes. Therefore, the treatment may have made a small difference in content knowledge for the treatment students.

I used Pre and Post Unit Teacher Checklists for Communication, which helped me to answer my third secondary question: *What impact does the ISN make on improving the way students communicate*? Table 4 shows the number of students using correct science terminology when they were asking and answering questions. I also recorded how well students communicated through their speech with partners, in writing in their ISN, and on their assessments. I found that with the implementation of the notebooks, my students incorporated higher levels of science terminology in the speech and writings.

Table 4.
Pre and Post Unit Teacher Checklist for Student Communication

AVG	Question 1: Asks questions using appropriate scientific terms	Question 2: Responds to questions using appropriate scientific terms	Question 3: Clearly expresses their understanding of the material in their speech	Question 4: Clearly expresses their understanding of the material in their written work	Question 5: Clearly expresses their understanding of the material in their writing through assessments
Pre Unit	1.8	2.6	2	2.2	2.2
Post Unit	2.6	3.2	2.8	3	2.6

Note. Average Pre and Post Unit ratings, (*N*=5).

During this observation I focused on the frequency with which each student was able to correctly participate in each category during the Pre and Post Unit. I rated their frequency of communication on not observed, occasionally observed, commonly observed, and usually observed in (Table 4). I discovered the ISN helped the majority of students communicate more effectively. There was an increase in the number of times they asked, and responded to, questions using appropriate scientific terms. Students also increased their ability to express their understanding of the material through their speech

and in their written work. The ability for students to express their understanding of the material through their writing in assessments did not change during the treatment.

Students from the treatment group completed the Pre and Post Unit Communication Survey (Appendix G) and this allowed me get information to answer my third secondary question: *What impact does the ISN make on improving the way students communicate*? Students answered questions regarding their confidence levels about how appropriately and clearly they felt they could express their understanding or knowledge of science content by either speaking or writing. Survey responses to the communication survey are shown in Appendix L. To calculate differences between the Pre and Post Unit, I combined the data for answers for *some* and *very much* as an appropriate level of communication and answers for *not at all* and *very little* as an inappropriate level of communication. There were several areas in which the students felt their level of communication had improved. The greatest gains in student confidence in communication were seen in participation with a partner (increased 10%), correct science terminology with a partner (20%), ability to orally communicate (10%) and participation in science teams (10%). Students also felt they improved in using correct scientific terminology in homework (5%) and quizzes (14%).

Unfortunately, there were areas in which the students felt their level of communication had remained the same. The data show there was no increase in the number of times students participated orally and used correct science terminology to explain their reasoning. In contrast to their views regarding oral communication of science knowledge, student confidence in their ability to communicate their knowledge of science in writing did not change. Interviews about student communication aided me in

obtaining more information on my third secondary question: *what impact does the ISN make on improving the way students communicate?* I conducted Pre Unit interviews about communication with five of the treatment students. Responses (Table 5) indicated that students felt it was difficult to participate in science class because they "don't know how to say or explain it in their own words." Another reason they did not participate is because they "don't know the answer or they are too shy." Post Unit interviews indicated that after having interactive science notebooks, students felt that it was much easier to participate in class. One student said "the ISN is like an easier form of the book just in case we don't understand the book." Another said "After having the ISN, I'm confident to participate because it made things easier."

Table 5.
Post Unit Communication Interview Responses

Communication Interview Questions	No	Yes
1) 1) Is it easier to participate in class with the use of your ISN?	20%	80%
2) Is it easier to participate with a partner with the use of your ISN?	20%	80%
3) Is it easier for you to participate in your science team with the use of your ISN?	40%	60%
4) Is it easier for you to communicate effectively on your homework, quizzes, or tests with the use of your ISN?	20%	80%
5) Do you feel confident in your ability to speak or write science content?	20%	80%

Note. (*N*=5).

Pre Unit interviews about communication indicated students felt it was challenging to communicate with a partner and on a science team. As one student stated "it might be hard for me to communicate to my team because other members don't like to talk." Another stated that "they don't understand what we are doing." Post Unit interview responses demonstrated that students felt communication with their peers had improved,

as one student explained: “It isn’t difficult anymore because my partner helps me and so does the ISN.” Another said “I feel more comfortable reading from a notebook and I don’t have to come up with things from my head and just say them.” Most students said it was still challenging to work in teams because “nobody in the team ever has the same answer.” Two students explained that “some students still did not know what was expected from them.” Others stated that science teams helped because “students could help one another and they can correct each other.”

Pre Unit interviews about communication showed it was difficult for students to communicate effectively on their homework, quizzes, and tests. In Post Unit interviews, students felt it was “easy now because we have our ISN to help us.” Another student said the “ISN will make it easier for us to understand our homework.” Pre Unit interviews about communication demonstrated that students did not have much confidence in their ability to speak or write science content, but their confidence did improve over the course of the study. One student said “It made me confident because I understand the facts that are given.” Another said “It helps too by helps us are English better [sic].” Another student said they felt “more confident because we are writing in the notebook and this makes us more confident in speaking.”

This study provides evidence that the implementation of ISNs into a middle school science classroom can positively impact student performance. Certain areas of engagement during teamwork and communication when the student worked alone did not improve. However, there were clear improvements found in many aspects of the students’ engagement, academic achievement, and communication skills in science.

INTERPRETATION

Given the positive outcomes from the use of ISNs, I believe that many science educators, no matter what grade level they teach, should consider implementing ISNs into their classrooms. Teachers would soon realize how much of an asset this would be in helping them focus on effective instruction. Using ISNs provides an opportunity to differentiate instruction to meet the needs of all students. The notebooks increase the amount of efficient communication between the teacher and the student and can also be used to record progress and data. One of the greatest benefits of using ISNs is as an assessment tool, which can shape the way the teacher instructs.

I have seen that students benefit from ISNs, by allowing them to make connections with the content and to process ideas. The notebook is an accumulation of their work throughout the year and the students can reflect upon it. The activities completed in the notebook allow students to develop the way they think, engage, and communicate. Students gather data, draw sketches, and create ideas about the content and represent it in a format that expresses understanding creatively. ISNs are available to students at all times to use to reference from and write in about their hands-on learning. These notebooks also provide students with the added bonus of an enhanced level of organization.

Engagement in Science

Almost all students improved in demonstrating visible interest and curiosity in the inquiry, asking on-topic questions and responding appropriately to questions. This may have been caused by the ISN or by the effect of sitting close to the students I was observing, which may have caused them to be more on task. Only a few students

improved in their ability to self-monitor their learning by staying on task, in making connections to self, text, and life experiences, and in engaging successfully with a partner or a small group. However, as a middle-school student, it can be challenging to self-monitor behavior. This also may have been due to groups having the tendency to get off task and be silly. Perhaps when students have a useful resource to use it can help individuals and groups stay more focused than they would otherwise be. No student exhibited an observable decrease in their level of engagement. I hope this was due to the fact that they were more involved in the lessons, because the ISN gave them an anchor point for activities, rather than just my presence near a group.

The student engagement surveys displayed an increase in engagement during class discussions, individual readings, and when giving presentations. Sometimes students give themselves more credit than they deserve; I felt they were less engaged during those particular activities. Students reported that their engagement decreased during teacher lectures, partner activities, note-taking, lab work, and computer work. I felt I observed the opposite of the findings; it was during those activities that students were most engaged. The student perception of engagement interview responses showed that in each category ISN helped to increase engagement. This could have been because each student wanted to give answers they thought I would like to hear and they wanted to make sure they did not get in trouble for being off task. It also could have been that the ISN truly made the students more engaged in all of the different areas.

Academic Achievement

The Pre and Post Unit student opinion surveys showed that students began using sources other than their textbook to study for upcoming quizzes and tests during the

treatment period. I think this was because students truly realized how valuable the notebook was to them in being able to earn a high assessment score. Many students felt that their science notes helped them earn higher grades on their homework. This made sense to me because their homework directly involved all the activities we completed in our notebooks and they had access to them when completing their homework.

The students' perception that they were more aware of what they need to do in order to do well on a science test increased during the treatment period. I feel this was due to all of the questions on the tests being generated from their ISNs. There was no change in the number of students who felt they were good at preparing for science assessments and earning high grades on them. I attribute this mainly to students failing to follow through with studying for assessments and taking the extra effort to re-read content. However, it could also due to such factors as the lack of time to study, English language issues, lack of interest in the topic, or not feeling confident in the test in general. Some students felt the ISN did not help them receive a higher grade on their quizzes. This may be due to not understanding the material to begin with, so having the notebook there to use during the quiz would not help them do better.

When I compared the summative assessment scores versus their ISN scores for the treatment group I did discover there was a link between a high ISN score and a high assessment score. This I attribute to the students who dedicate a substantial amount of time to make sure all class notes and activities are correct in their ISN. These same students also put in the same effort and attitude towards preparing and completing the final assessment and vice-versa.

Comparing the assessment data for quizzes and tests from the treatment group to the non-treatment group showed only a minimal amount of improvement with the use of ISNs. Initially, I was extremely disappointed with my assessment results. Treatment students barely showed that all this time was worthwhile. Then I realized that during the treatment, I had changed the way I created my assessments. Instead of direct answers, multiple choice, or fill in the blank, with surface level thinking, I created more short- or long-answer written responses for which students had to display their critical thinking skills and explain their reasoning behind their answers. The correct use of science vocabulary on my assessments became extremely important because it was the application of their true understanding of the material. On my assessments during this treatment, students also had to predict the outcome of certain events and describe the meaning behind certain models. In that way, I felt I might have skewed my own data because I made the assessments more challenging. I realize that to have more accurate data, I should have kept the same assessment format as I previously used. Teaching with ISNs naturally made me increase the rigor and expectations I placed upon my students. I believe with more practice their ability to perform well on assessments would improve over time.

Overall, there were other contributing factors to low assessment scores. One is that although the students had the notebooks as a resource, perhaps they did not know how to utilize them to explain their understanding. Another reason is the language barrier and the challenge the science academic language posed on my students. Perhaps this is why students continued to have difficulty explaining and applying the content they learned.

Communication Skills

The Pre and Post Unit teacher checklist for student communication showed the ISN helped the majority of students increase the number of times they asked questions, and responded to them, using appropriate scientific terms. This could have been caused by ISNs not requiring one specific way to complete an activity correctly. ISNs increased students' ability to express their understanding of the material through speech and written work. This may be because students wrote responses and practiced reading them with a partner before they were shared in front of the class. Students' ability to express their understanding of the material through their writing in assessments remained the same. This might be due to the fact that they were by themselves and did not have others to confirm or change the way they wrote; they often wrote how they spoke, which many times did not make sense. Or perhaps longer-term gains in understanding do not manifest until much later on, which will then be seen through their writing.

The student communication surveys showed that with the use of the ISN, students felt their level of communication had improved when they participated with a partner and in science teams. This might be due to feeling comfortable working with their partner of their choice. Students also felt that they were capable of using the correct science terminology to explain their understanding on their homework and quizzes, while speaking, and to explain their reasoning with a partner. I believe this was because they had continual access to their notes which contained the correct definitions of their science terminology.

There were also areas where students felt that their level of communication had remained the same. This included the number of times they participated and used correct

science terminology to explain their reasoning. However, I believe it is difficult to be personally aware of how much one correctly participates in a discussion. I now wish I had videotaped the classes pre and during treatment and had counted the amount and quality of participation and quality of it versus rather than relying on what the students thought of their own participation. Perhaps students' participation increased even though they did not perceive it had increased. Students felt that communication was easier in science class with a partner and in science teams, possibly due to students being able to rely on each other for help. Students' ability to communicate effectively increased when they were able to use their ISN on homework, quizzes and tests. Students' confidence in their ability to write and speak about science content was also positively affected. I attribute this to having a resource for them to rely upon, instead of them needing to come up with answers from memory.

Communication in my class became more critical than ever. I felt the ISN was an effective tool that taught students to become proficient communicators with one another and myself. Although I did not observe extreme changes, it takes time for students to become more comfortable communicating. Communication in science can be a challenge when many of these students struggle with English to begin with.

There were other obstacles that could have impacted my data. Many of my students had vision issues that they did not get corrected, so they had difficulty seeing the whiteboard the entire year. This may have limited the amount of content that my students could understand and it would have ultimately affected their assessment scores. Several Hmong students at my school also lacked self-advocacy because their culture tends to admonish children for asking questions or questioning adults. This meant that students

would typically not state when they could not see or if they did not have a resource they needed. Even more importantly, the students would also not let me know when they did not understand the content or what they were required to do.

There were also time limitations placed on my students due to the many issues they encountered at home. Commonly, and on a daily basis, my students were responsible for taking care of all of their younger siblings and had a lot of household chores to complete. Homework and studying were not a top priority for them because they were responsible for watching younger children, despite them being children themselves. Some students also had limited transportation to and from school, which did not allow them to receive extra help.

One of the largest deficits that I believe impacted the data was the limited student and teacher resources. Students lacked colored pencils, markers, scissors, and glue that was needed to complete certain activities in their ISN. I did my best to combat this issue by telling students to let me know privately if they needed resources and I would purchase those items from my science fee money. I also provided all students with a blank notebook because many could not afford it. Most students also lacked the access to technology. Even if they did own a computer, it may have been shared between four or more people. Limited availability to technology could have prevented my students from easily looking up answers to their questions or finding information that would have helped them be more successful in my science class. Also, despite the high number of English Language Learners (ELL) and English as a Second Language (ESL) students, there was no ESL teacher available to help in any of my science classes. Having a bilingual English and Hmong ESL teacher would have been extremely beneficial to help

all students improve in engagement, thinking, and communication in science. Despite this, I did my best to meet the learning needs of all of my students, and I modified their work and made accommodations to help them gain as much knowledge as possible.

VALUE

This capstone experience has changed the way I think about engagement, communication, assessments, note-taking/instruction, organization and data collection in my classroom. I now better understand what engagement is and what it truly looks like. Students may appear engaged, but when you read what they wrote, you can tell if they were simply doing busy work or effective, meaningful activities that they were motivated to complete. I personally feel that the ISNs kept my students on task and completing meaningful activities. I believe that the notebooks allowed my students to take control over their learning because they were able to make more decisions and represent their understanding in multiple outlets. For this reason and many others, I decided that I am going to implement ISNs into my science classes for years to come. I would also highly recommend this learning tool to any science teacher who is considering incorporating strategies to create a more beneficial curriculum for their students.

One area of communication that I did not observe in my study was the communication between the students and their parents or guardians. This will be a future goal of mine to make this specific type of communication more important. I would like to find a better way that my students can express to their parents what they have learned in my class and I believe this can be done through ISNs.

As a teacher I naturally create a lot of graphic organizers but the ISNs made me incorporate even more into my curriculum. I realized the importance of slowing down

and letting students absorb the information and truly interact with the content. The note-taking in the ISNs helped me analyze each page and determine how the students benefited from the specific informational format. I chose more meaningful activities because I focused more on standards and what I wanted my students to learn, which was analogous to backwards design. In addition to this I also incorporated more labs into my instruction.

One thing I would have done differently during the treatment was to continue to teach with the use of PowerPoint to complement ISNs. The two approaches need not be mutually exclusive. It is likely that my instruction would have greatly improved with the implementation of both of these strategies and the results would have been more effective learning.

I am a very organized teacher but ironically through the use of interactive notebooks, I realized how even more organized I had to become. I also learned how beneficial it was for the students to have the same level of organization as the material covered in class. ISNs provided a purpose, a sense of importance, and a convenient location for each activity we completed. In later units, I would refer to specific information we covered previously and then we could page right to it to review the content. Also students would rarely lose any papers given out in class. I learned how important it was to have my students with all of their resources at their fingertips. This was essential when they were trying to support their reasoning to answers on formative and summative assessments. The organizational skills of my students improved over the treatment period. Typically disorganized students cared even more than others about their

table of contents and keeping up with the rest of the class. The benefit to less-organized students is another reason why I will continue to use these notebooks in my classroom.

Looking back at this project, I wish I had collected more objective data that was not based on the student's choice/opinion/feelings, but was based on what was actually seen or learned on assignments in the classroom. What students believe and what really happens can be two different things. However, I do see the value in qualitative approaches because they assess the feelings of students.

I also wish there had been an outside observer to collect checklist observational data. An outsider would not be biased and their observations would truly reveal what they saw rather than what they hoped or wanted to see. Perhaps video recording sessions and observing all the students during the same lesson would make this type of data more reliable.

I have learned the importance of collecting data in my classroom. The results showed me how much growth was taking place and how students perceived what they were doing and learning in my classroom. I can make evidence-based decisions to change my teaching techniques and strategies. Data collection benefits my teaching and the amount of learning that takes place in my classroom.

This capstone project has been one of the most challenging things I have had to complete. In the end it has truly been valuable to my career and my success as a graduate student. I have had the opportunity to experience the benefits of implementing ISNs in middle school classrooms. I also learned how I can change, and what I can do to grow as a professional, to improve the level of science education my students receive. My ultimate goal is to teach my Hmong students to the best of my ability, so that they will

become successful high school students, and adults. Ideally, their culture will prosper from all the benefits of an extensive and useful science education.

REFERENCES CITED

Chesbro, R. (2006). Using Interactive Notebooks for Inquiry-Based Science. *Science Scope*, Issue and volume style as in Young 30-34.

Crippen, C.W. (2009). Integrating Interactive Notebooks. *The Science Teacher*, 51-55.

Exeter, D.J., Ameratunga, S., Ratima, M., Morton, S., Dickson, M., Hsu, D. & Jackson, R. (2010). Student engagement in very large classes: the teachers' perspective. *Studies in Higher Education, 35*(7), 761-775.

Gilbert, J., & Kotelman, M. (2005, November). Five Good Reasons to Use Science Notebooks. *Science and Children*, 28-32.

Hargrove, T., & Nesbit, C. (2003). *Science notebooks: Tools for increasing achievement Across the curriculum.*(ERIC Document Reproduction Service No. Ed 482720). Retrieved September 3, 2015, from http://www.ericdigests.org/2004-4/notebooks.htm.

Marcarelli, K. (2010). *Teaching Science With Interactive Notebooks*. Thousand Oaks; Corwin Press.

Perkins, R. R. (2008). Making Thinking Visible. *Educational Leadership*, 57-61.

The Hmong Culture (2015). Retrieved from http://www.myhapa.org/about-us/the-hmong-culture/

Young, J. (2003). Science interactive notebooks in the classroom. *Science scope.* 26(4), 44.

Yuruk, N., Beeth, M.E., & Andersen, C. (2008). Analyzing the effect of metaconceptual teaching practices on students' understanding of force and motion concepts. *Research in Science Education, 39*(4), 449-475.

APPENDICES

APPENDIX A

STUDENT ENGAGEMENT SURVEY

Name: _____

Student Engagement Survey

Directions: Please answer the following questions as honestly as you can, using the scale below. Rate the following classroom activities and assignments on how much they interest or engage you. How much meaning or value does the activity have for you? Your responses will not impact your grade in Science.

	1= Not at all	2=Very little	3=Some	4=Very much
1) Teacher lectures	1	2	3	4
2) Class discussions	1	2	3	4
3) Individual readings	1	2	3	4
4) Teamwork	1	2	3	4
5) Projects	1	2	3	4
6) Giving Presentations	1	2	3	4
7) Taking notes	1	2	3	4
8) Using computers for school work	1	2	3	4
9) Lab work	1	2	3	4
10) Partner activities	1	2	3	4

APPENDIX B

TEACHER CHECKLIST OF STUDENT ENGAGEMENT

Teacher Checklist of Student Engagement

1=Not Observed 2=Occasionally Observed 3=Commonly Observed 4=Always Observed

Student Name	**Question 1:** Demonstrates interest and curiosity in the inquiry	**Question 2:** Asks on-topic questions and responds appropriately to questions	**Question 3:** Is able to self-monitor their own learning by staying on task	**Question 4:** Makes connections to self, text, and life experiences	**Question 5:** Engages successfully with a partner or in a small group
	1 **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**
	1 **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**
	1 **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**
	1 **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**	**1** **2** **3** **4**

APPENDIX C

PRE AND POST UNIT STUDENT PERCEPTION OF

ENGAGEMENT INTERVIEW QUESTIONS

Pre Unit Student Perception of Engagement Interview Questions

1) What can make lectures from teachers interesting?
2) What makes you want to get involved in class discussions?
3) What makes you more interested in reading science material?
4) What makes you stay engaged and on task during teamwork?
5) Do you value group projects? Explain why or why not?
6) What makes a presentation by a fellow student interesting?
7) How could taking notes be more enjoyable?
8) Does using computers or technology help to keep you engaged? Why or why not?
9) Does completing lab work make you excited for a science lesson?
10) Are you more engaged when you work alone or with a partner? Explain why.

Post Unit Student Perception of Engagement Interview Questions

1) Do interactive science notebooks help make lectures from teachers more interesting? Explain why.
2) Do interactive science notebooks help you get more involved in class discussions? Explain why.
3) Do interactive science notebooks help you become more interested in reading science material? Explain why.
4) Do interactive science notebooks help you stay engaged and on task during teamwork time? Explain why.
5) Do interactive science notebooks help to make taking notes more enjoyable? Explain why.
6) Do interactive science notebooks help you complete lab work and make you more excited for the science lesson? Explain why.
7) Do interactive science notebooks help you become more engaged when you work alone or with a partner? Explain why.

APPENDIX D

STUDENT OPINION SURVEY

Name: _____

Student Opinion Survey

Directions: Please answer the following questions as honestly as you can, using the scale below. Your responses will not impact your grade in Science.

1= Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

1) In general, I am good at studying and preparing for assessments in all of my classes.

1 2 3 4 5

2) I am good at studying and preparing for assessments, specifically in science class.

1 2 3 4 5

3) I use only my textbook to study for an upcoming test or quiz.

1 2 3 4 5

4) I use my textbook and/or my notes, and/or any other resources available like study guides to help me study for an upcoming quiz.

1 2 3 4 5

5) I use my textbook and/or my notes, and/ or any other resources available like study guides to help me study for an upcoming test.

1 2 3 4 5

6) Using my science notes helps me to receive high grades on daily homework assignments.

1 2 3 4 5

7) Using my science notes helps me to receive high grades on chapter quizzes.

1 2 3 4 5

8) I usually study on my own time for science tests and quizzes.

1 2 3 4 5

9) I learn best when studying with team members or when studying together as a class versus by myself. 1 2 3 4 5

10) I understand what I have to do on most science tests to do well.

1 2 3 4 5

11) I am capable of receiving a high grade on most science assessments.

1 2 3 4 5

APPENDIX E

INTERACTIVE SCIENCE NOTEBOOK GRADING RUBRIC

Interactive Science Notebook Grading Rubric

Your notebook will be collected for grading during each unit, according to the following rubric:

100%	**TOTALLY AWESOME!** Notebook contents are neatly completed, all pages are numbered, titled and dated. Right-side/left-side topics are correct and contents are organized according to class guidelines. Table of Contents reflects ALL entries to date. Right-side notes go BEYOND basic requirements. Left side shows IMPRESSIVE, IN-DEPTH scientific thought and effort.
90%	**AWESOME** Notebook contents are neatly completed, all pages are numbered, titled and dated. Right-side/left-side topics are correct and contents are organized according to class guidelines. Table of Contents reflects all entries to date. Right side notes largely MEET requirements and some go beyond. Left side shows IN-DEPTH thought and effort.
85%	**PRETTY DARN GOOD** Notebook contents are MOSTLY NEAT and complete (at least 90%), pages numbered, titled and dated. Right-side/left-side topics are correct and organized with no more than 2 assignments incorrectly placed. Table of Contents reflects 90% of all entries up to date. Right side notes meet requirements. Left side shows a basic understanding of content topics, shows some thought and effort.
75%	**KICK IT UP A NOTCH** Notebook contents are legible, complete (at least 80%), pages numbered, titled and dated. Right-side/left-side topics are correct and organized with no more than 4 assignments incorrectly placed. Table of contents reflects at least 80% of all entries to date. Right side notes nearly meet minimum requirements. Left side shows a limited understanding of content topics, limited thought and effort.

65%	**GET YOUR HEAD IN THE GAME** Notebook contents are sloppy or incomplete (50%), many pages are not numbered, titled or dated. Right-side/left-side is inconsistent and contents are unorganized with more than 5 assignments incorrectly placed. Table of contents shows limited attempts at keeping entries up to date. Right side contents incomplete. Left side shows only a superficial understanding and/or some inaccuracies, little thought or effort.
55%	**UNACCEPTABLE FOR MIDDLE SCHOOL WORK** Notebook turned in but too incomplete to score well. Majority of pages are missing or incomplete. Dating and labeling of pages is inconsistent. Right side contents incomplete and missing. Left side shows minimal understanding, not neatly written, minimal effort.

APPENDIX F

PRE AND POST UNIT NORMALIZED AVERAGE GAINS

IN QUIZ AND TEST SCORES

Pre Unit and Post Unit Normalized Average Gains in Quiz and Test Scores, (N=21)

Student Number	Non-Treatment Normalized Average Test Gain	Non-Treatment Normalized Average Quiz Gain	Student Number	Treatment Normalized Average Test Gain	Treatment Normalized Average Quiz Gain
1	-0.77	-1.61	1	-0.46	0.68
2	0.25	0.44	2	0.33	-0.49
3	-0.09	0.39	3	-0.46	0.12
4	-0.64	-0.28	4	0.29	0.37
5	0.54	0.65	5	-0.16	-0.51
6	-0.42	-1.28	6	0.82	0.04
7	0.59	0.5	7	0.71	0.45
8	0.33	-0.46	8	0.52	-0.34
9	-0.45	-0.25	9	-0.95	-0.69
10	-0.47	-1.05	10	0.72	-1.05
11	0.22	-0.22	11	0.16	0.94
12	0.75	0.63	12	0.58	0.17
13	0.125	-0.04	13	0.23	0.23
14	-0.36	-0.73	14	0.46	0.49
15	-0.33	-1.16	15	-0.66	-0.37
16	0.21	-0.05	16	0.57	0.81
17	-0.93	-1.75	17	0.13	0.18
18	-1	-1.09	18	0.17	0.71
19	0.33	0	19	0.73	0.28
20	-0.2	-1.04	20	0.43	-0.63
21	0.48	0.57	21	-1.3	-0.92
Average	-0.087	-0.372	Average	0.136	0.022

APPENDIX G

STUDENT COMMUNICATION SURVEY

Name: _____

Student Communication Survey

Directions: Rate the level at which you participate/communicate in the following classroom activities. 1= Not at all 2=Very little 3=Some 4=Very much

1) How often do you participate in class? 1 2 3 4

2) When you do participate, how often do you use correct science terminology to explain your reasoning clearly, when you respond during class?
1 2 3 4

3) How often do you participate with a partner? 1 2 3 4

4) When you do participate, how often do you use correct science terminology to explain your reasoning clearly, when you work with a partner?
1 2 3 4

5) How often do you participate in your science team? 1 2 3 4

6) When you do participate, how often do you use correct science terminology to explain your reasoning clearly, when you work with your science team?
1 2 3 4

7) How often do you use correct science terminology to explain your understanding clearly, when you write answers on your homework? 1 2 3 4

8) How often do you use correct science terminology to explain your understanding clearly, when you write answers on your quizzes? 1 2 3 4

9) How often do you use correct science terminology to explain your understanding clearly, when you write answers on your tests? 1 2 3 4

10) In general, how confident do you feel about your ability to communicate your knowledge of science by speaking? 1 2 3 4

11) In general, how confident do you feel about your ability to communicate your knowledge of science by writing? 1 2 3 4

APPENDIX H

PRE AND POST UNIT STUDENT PERCEPTION OF

COMMUNICATION INTERVIEW QUESTIONS

Pre Unit Student Perception of Communication Interview Questions

1) Why can it be difficult to participate in class?

2) What can a teacher do to help you communicate more effectively in class?

3) Why can it be difficult to participate with a partner?

4) What can a teacher do to help you communicate more effectively with a partner?

5) Why can it be difficult for you to participate in your science team?

6) What can a teacher do to help you communicate more effectively in your science team?

7) Why can it be difficult for you to communicate effectively on your homework, quizzes, or tests?

8) What can a teacher do to help you communicate effectively on your homework, quizzes, or tests?

9) Why would someone not feel confident in his or her ability to speak or write science content?

10) What can a teacher do to help you feel more confident in your ability to speak or write science content?

Post Unit Student Perception of Communication Interview Questions

1) Is it difficult to participate in class with the use of your ISN?

2) Is it difficult to participate with a partner with the use of your ISN?

3) Is it difficult for you to participate in your science team with the use of your ISN?

4) Is it difficult for you to communicate effectively on your homework, quizzes, or tests with the use of your ISN?

5) Do you feel confident in your ability to speak or write science content?

APPENDIX I

TEACHER CHECKLIST OF STUDENT COMMUNICATION

Teacher Checklist of Student Communication

1=Not Observed 2=Occasionally Observed 3=Commonly Observed

4=Always Observed

Student Name	**Question 1:** **Asks questions using appropriate scientific terms**	**Question 2:** **Responds to questions using appropriate scientific terms**	**Question 3:** **Clearly expresses their understanding of the material in their speech**	**Question 4:** **Clearly expresses their understanding of the material in their written work**	**Question 5:** **Clearly expresses their understanding of the material in their writing through assessments**
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4

APPENDIX J

PRE AND POST STUDENT ENGAGEMENT SURVEY RESPONSES

Pre and Post Unit Student Engagement Surveys Responses, (N=21)

Engagement Questions	Not at all	Very little	Some	Very much
1) Teacher lectures			85.7%	14.3%
		4.7%	90.4%	9.5%
2) Class discussions		19%	66.6%	14.2%
			57.1%	42.8%
3) Individual readings	14.2%	14.2%	33.3%	38%
	4.7%	33.3%	33.3%	28.5%
4) Teamwork		14.2%	33.3%	52.3%
			38%	61.9%
5) Projects		4.7%	47.6%	47.6%
	4.7%	4.7%	47.6%	42.8%
6) Giving Presentations	14.2%	42.8%	33.3%	9.5%
	4.7%	28.5%	33.3%	33.3%
7) Taking notes		9.5%	47.6%	42.8%
		14.2%	52.3%	33.3%
8) Using computers for school work		14.2%	33.3%	52.3%
		19%	42.8%	38%
9) Lab work			14.2%	85.7%
			23.8%	76.1%
10) Partner activities		9.5%	33.3%	57.1%
	4.7%		71.4%	23.8%

Notes. Pre Unit, top row; Post Unit, bottom row.

APPENDIX K

PRE AND POST UNIT OPINION SURVEY RESPONSES

Pre and Post Unit Opinion Survey Responses, (N=21)

Opinion Statements	SD	D	N	A	SA
1) In general, I am good at studying and preparing for assessments in all of my classes.		9.5%	52.3%	38%	38%
		9.5%	66.6%	23.8%	
2) I am good at studying and preparing for assessments, specifically in science class.		9.5%	66.6%	19%	4.7%
		23.8%	38%	38%	
3) I use only my textbook to study for an upcoming test or quiz.	4.7%	33.3%	38%	14.2%	9.5%
		57.1%	33.3%	4.7%	4.7%
4) I use my textbook and/or my notes, and/or any other resources available like study guides to help me study for an upcoming quiz.		4.7%	19%	47.6%	23.8%
			19%	66.6%	14.2%
5) I use my textbook and/or my notes, and/ or any other resources available like study guides to help me study for an upcoming test.	9.5%		19%	33.3%	38%
		4.7%	19%	47.6%	23.8%
6) Using my science notes helps me to receive high grades on daily homework assignments.			42.8%	23.8%	33.3%
		4.7%	42.8%	42.8%	9.5%
7) Using my science notes helps me to receive high grades on chapter quizzes.			28.5%	52.3%	19%
		14.2%	42.8%	19%	19%
8) I usually study on my own time for science tests and quizzes.	9.5%		47.6%	33.3%	9.5%
		4.7%	38%	28.5%	28.5%
9) I learn best when studying with team members or when studying together as a class versus by myself.		14.2%	28.5%	14.2%	42.8%
		19%	38%	28.5%	14.2%
10) I understand what I have to do on most science tests to do well.		9.5%	38%	33.3%	19%
		9.5%	23.8%	42.8%	23.8%
11) I am capable of receiving a high grade on most science assessments.		19%	52.3%	23.8%	4.7%
		4.7%	61.9%	23.8%	4.7%

Notes. Strongly disagree, SD; Disagree, D; Neutral, N; Agree, A; Strongly agree, A. Pre Unit, top row; Post Unit, bottom row.

APPENDIX L

PRE AND POST UNIT COMMUNICATION SURVEY RESPONSES

Pre and Post Unit Communication Survey Responses, (N=21)

Communication Questions	Not at all	Very little	Some	Very much
1) How often do you participate in class?		4.7%	71.4%	23.8%
		4.7%	90.4%	4.7%
2) When you do participate, how often do you use correct science terminology to explain your reasoning clearly, when you respond during class?		33.3%	61.9%	4.7%
		33.3%	52.3%	14.2%
3) How often do you participate with a partner?		14.2%	42.8%	42.8%
	4.7%	4.7%	42.8%	52.3%
4) When you do participate, how often do you use correct science terminology to explain your reason clearly, when you work with a partner?		23.8%	66.6%	9.5%
		4.7%	71.4%	23.8%
5) How often do you participate in your science team?		14.2%	33.3%	52.3%
		4.7%	23.8%	71.4%
6) When you do participate, how often do you use correct science terminology to explain your reason clearly, when you work with your science team?		23.8%	52.3%	23.8%
		23.8%	66.6%	14.2%
7) How often do you use correct science terminology to explain your understanding clearly, when you write answers to your homework?		19%	71.4%	9.5%
		28.5%	42.8%	33.3%
8) How often do you use correct science terminology to explain your understanding clearly, when you write answers to your quizzes?	4.7%	19%	52.3%	23.8%
		9.5%	85.7%	4.7%
9) How often do you use correct science terminology to explain your understanding clearly, when you write answers to your tests?	4.7%	14.2%	71.4%	9.5%
		33.3%	52.3%	19%
10) In general, how confident do you feel about your ability to communicate your knowledge of science by speaking?	4.7%	42.8%	38%	14.2%
		38%	38%	23.8%
11) In general, how confident do you feel about your ability to communicate your knowledge of science by writing?	14.2%	28.5%	38%	19%
		47.6%	23.8%	33.3%

Note. Pre Unit, top row; Post Unit, bottom row.