THE EFFECTS OF FORMATIVE ASSESSMENTS WITH TARGETED, REAL WORLD, CURRENT EVENTS, AND HANDS ON ACTIVITIES ON STUDENTS' UNDERSTANDING OF ELEMENTARY SCHOOL SCIENTIFIC CONCEPTS IN AN ENGLISH LANGUAGE LEARNING ENVIRONMENT

by

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STATEMENT OF PERMISSION TO USE

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

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DEDICATION

I dedicate this paper to my parents, Paul and Wendi Rocheleau. Throughout my life, they have shown me how to persevere through life’s challenges and still enjoy it along the way. This paper required both of those skills.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This study examined the effects of formative assessments with targeted, real-world, current events, and hands-on activities on students' understanding of elementary school scientific concepts in an English language-learning environment. The students used targeted, real-world, current events, and hands-on activities to facilitate their learning of scientific concepts. Many data collection instruments were used, including preunit, postunit, and delayed assessments, interviews, surveys, colleague observations, and a teacher's reflection journal. The study found students had a stronger grasp of the concepts after the treatment. However, the study showed mixed results regarding students' motivation.

INTRODUCTION AND BACKGROUND

After considering many problems afflicting the science education of young persons during my reflections about teaching, the most prolific cause of student underperformance that I have been able to deduce from my teaching experience is an apathetic attitude towards the sciences. It appears that as long as students are unable to comprehend key scientific concepts, there will be a lack of enthusiasm towards the discipline. From my experience, people rarely get excited about things they do not understand. As an English Language Learner (ELL) and science teacher, I have noticed the same is true of students trying to read a story or learn science they don't understand. When this happens, they soon lose interest.

Formative assessments help teachers better understand their students' strengths and weaknesses. Sharing the results of these assessments with students closes the feedback loop of understanding. This sharing is helpful because it makes students aware of their own strengths and weaknesses. I have noticed formative assessments are useful while teaching ELL. Students are often shy to candidly admit their lack of understanding. When they are prompted to explain something, or asked if they understand a particular part of class, they will usually admit their lack of understanding.

I have also observed that real-world, current events, and hands-on activities help get students more enthused than traditional lecturing, and this increased enthusiasm helps increase the odds of successfully closing the feedback loop of understanding.

Consequently, I've chosen to study the effects that formative assessments, coupled with targeted real-world, current events and hands-on activities, have on students' understanding and enthusiasm for the sciences. Sadi and Cakiroglu (2011) explained that, "hands-on instruction may enhance a better learning success compared to traditional instruction" (p. 95). This topic is important to me because I, as a student, have experienced how much more productive and enjoyable a curriculum can be if it is interlaced with hands-on activities. In addition, I believe that incorporating these measures will help to better my attitude towards teaching and my profession by making it more enjoyable and, thus, more rewarding.

I taught, with the help of a bilingual (Chinese and English) co-teacher, one first-grade class that had 13 students between the ages of 6 and 7. The curriculum was a yearlong introduction to English reading and its usage. During this time, they were introduced to scientific concepts in the course of this project.

My project focus question was, what are the effects of using formative assessments with targeted real-world, current events and hands-on activities on 6 and 7-year-old English Language Learning (ELL) students' understanding of scientific concepts as students learn English as a second language? My project subquestions were as follows: what are the effects of using formative assessments with targeted real-world, current events and hands-on activities on students' enthusiasm for learning about science as students learn English as a second language; what are the effects of using formative assessments with targeted real-world, current events and hands-on activities on students' long-term memory of scientific concepts as student learn English as a second language;

and what are the effects of using formative assessments with targeted real-world, current events and hands-on activities on my attitude as a teacher towards my students?

Hands-on activities are characterized by Sadi and Cakiroglu (2011) as, "learning by doing" (p. 87). In addition, formative assessments are defined by Black and Wiliam (1998) as "all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged" (p. 7-8).

Several of my family members and professional colleagues from MSU were instrumental in helping me complete this project. The first person who helped me was my mother, Wendi Rocheleau. I always have, and still do, look to her for advice on English usage and grammar. She painstakingly read and reread my paper to make sure it was grammatically correct and that my writing was concise. The next member of my support team was my project reader, Dr. Christian Bahn, a professor of chemistry at MSU. I took one of Dr. Bahn's classes in the fall of 2011 and I found him very helpful and insightful. In addition to help from both of them, I had the help of my project advisor, Jewel Reuter, Ph.D.

CONCEPTUAL FRAMEWORK

Prior evidence has shown the importance of using targeted real-world, current events and hands-on activities to augment students' enthusiasm and attitudes towards the sciences, and to support and enhance their level of understanding of key scientific concepts. Most of these studies indicate that using these techniques improves students' attitudes towards the sciences and their ability to comprehend key concepts. It is not, however, always evident that such intervention will produce markedly better effects than nonintervention. The general idea of using such interventions is a worthwhile endeavor, but the method and quality with which they are delivered can mean the difference between a robust transformation in learning and attitude or a marginal improvement.

A study by Sadi and Cakiroglu (2011) is a classroom study of 140 sixth-grade students that were all 12 years of age and learning about anatomical biology. Sadi and Cakiroglu focused on the effects that hands-on activities had on a sample of students regarding their ability to comprehend scientific concepts, and on their attitudes towards the curriculum and subject as a result of this intervention. As they explain in their paper, hands-on is defined as learning by doing. More specifically, "it involves enabling the child's ability to think critically in a total learning experience" (p. 88). Sadi and Cakiroglu also found that students' successes increase when students are actively involved in manipulating objects in order to gain knowledge. Students also exhibited a greater degree of motivation when working with physical objects, and are more excited about lessons when they get to work with such objects. From their study, one can deduce that hands-on activities help foster a greater degree of enthusiasm among science students, and perhaps a greater degree of understanding. As Sadi and Cakiroglu concluded, "hands-on activity enriched instruction increased students' achievement in science more than the traditional instruction did" (p. 94).

Falk (2012) offers some key insights into the benefits of using formative assessments and pedagogical content knowledge. He writes, “As a classroom practice, formative assessment can have a considerable positive impact on student learning” (p.266). In addition to Falk’s work championing the use of formative assessments, Black and Wiliam (1998) write in their meta-analysis of 21 different studies that concerned student assessment given to a range of students between preschool and 12^{th} grade that, “attention to formative assessment can lead to significant learning gains” (p. 17). It is clear from these two papers that the use of formative assessments can positively enhance student learning.

Holstermann, Grube, and Bögeholz found that hands-on activities often “positively influence students’ interests in activities” (2010, p. 751). In their research, they studied 141 eleventh-grade grammar school biology students in North Germany. After dividing the sample population into a control and a treatment group, they facilitated the instruction of the treatment group with hands-on activities involving experimenting, dissecting, working with microscopes, and classifying organisms. Upon reviewing their data, they realized that in regard “to seven specific hands-on activities, (we) they found a positive influence of experience on students’ interest in the respective activity” (p. 749). However, the results, while positively correlated across the board, were less definite than they had anticipated. In several instances, “(we) they did not detect any significant differences in interest between adolescents with experience and those without” (p. 749). Therefore, while it does not seem that hands-on intervention always has the largest impact on students regarding their interest in a subject, it is statistically probable that hands-on intervention will yield a greater interest in the subject than nonintervention.

Zacharia, Loizou, and Papaevripidou (2012) also conducted a study in support of Holstermann et al.'s work. In their study, Zacharia et al. studied whether or not physicality was an important part of the scientific learning process as it applies to kindergarten students. They utilized a pretreatment and posttreatment study design where they studied a class of 20 kindergarteners. The students were taught how to manipulate a balance beam and to differentiate between objects based on their masses. After reviewing the data, Zacharia et al. found that "it appears that under certain conditions, physicality, touch, could be a prerequisite for students' learning" (p. 454). Therefore, it is foreseeable that adding hands-on exercises into a kindergarten classroom will improve students' memory of the concepts taught.

In addition to hands-on activities, my project also focused on the effects of using real-world current events to try and positively affect students' attitudes and understanding of the material. In support of this idea regarding attitudes, is a study by Linnenbrink-Garcia et al. (2010), which studied the effects of using material to stimulate students' situational interest in various academic settings. Their research was conducted as a classroom study where they studied "858 undergraduate students from five introductory psychology classes" (p. 651). In Linnenbrink-Garcia et al's. study, they make the distinction between two kinds of interests, individual interest and situational interest. Contrary to individual interests, which exist in individuals regardless of any particular situation, "situational interest emerges in response to features in the environment" (p.

648). They also noted that, "theoretical models of individual interest identify situational factors as critical in the development of individual interest" (p. 648). Therefore, it seems appropriate to meld real-world situation-based current events into a classroom curriculum to stimulate both immediate student interest and to help encourage the long-term development of an individual interest in the subject.

Kuo-Chung Hsu (2012), an elementary school science teacher in Kaohsiung, Taiwan, wrote a paper in support of these theories, specifically regarding constructivist instruction of elementary school students. Constructivism is a theory of knowledge acquisition that purports learners are best served by actively learning or discovering new knowledge instead of being passively subjected to it. In his experiences as a teacher, Kuo-Chung Hsu gradually transitioned from being a textbook-centered teacher to a strong constructivist instructor. Hsu remarked that, "he came to the idea that he should provide students with more opportunities of thinking as well as to presenting their own thoughts" (p. 66).

In regard to students maintaining their learned knowledge for a long period of time, Crippen and Brooks (2009) make a distinction between working memory and long-term memory. Crippen and Brooks define working memory as "the construct limiting the capacity of short-term recall" (p. 35). One's capacity for working memory is also known as their fluid intelligence. On the other end of the memory spectrum is long-term memory, which is what we are able to recall after a considerable amount of time has passed since our last contact with the material. In their study, Crippen and Brooks studied contemporary theories of memory and used worked examples. They did not test any theories on sample populations. They did find a strong correlation between memory and student-motivation. To this end, they stated:

> Prior knowledge is far and away the largest predictor of new learning, while natural ability plays a minor role. Therefore, the largest obstacle to student learning can be tackled by instruction. As a primary outcome, successful chemistry teachers focus instruction on motivating students to develop a deep, well integrated knowledge of chemistry. (p. 40)

It is clear that motivating students is an important part of facilitating the development of their memory. This is further supported by Linnenbrink-Garcia et al. (2010) who demonstrated that hands-on activities, real-world activities, and current events could positively affect the motivation of students.

Wang (2011) qualitatively studied the motivations of science teachers in Taiwan. Wang's study dealt with 22 science intern teachers in Taiwan who had just completed their internships in which they implemented robust hands-on activities. The study concluded that "teachers expressed a high-level of satisfaction with teaching science and interacting with their students in their intern schools." (p. 405). It is clear that a more robust intervention and interaction with students will also lead to a more fulfilling experience for the teacher.

Another topic that I studied is teaching science to English Language Learning (ELL) students. To this end, Hadaway, Vardell, and Young wrote an article in *Book Links* (2002). In it, they mentioned that when they "encounter subjects with which they have [had] no prior knowledge or experience, ESL students find the structure of textbooks confusing and the level of new vocabulary – especially technical terminology – almost paralyzing" (p.31). Therefore, it seemed essential to motivate the students as much as possible so they would be able to have the best chance to overcome this paralysis.

Through the research, it has been indicated that implementing a curriculum based on real-world, current events, and interactive hands-on activities ought to lead towards a greater degree of student understanding and comprehension of scientific concepts. In addition, such an intervention should augment students' enthusiasm for learning about science and their ability to retain what they have learned for a long period of time.

METHODOLOGY

Project Treatment

To realize the effectiveness of using formative assessments with hands-on activities, interactive activities, and targeted real-world events on students' understanding of scientific concepts, I compared data collected from using robust intervention (treatment units) with data collected from an intervention-free unit (a nontreatment unit). My project took five weeks to complete. It started with a one week-long nontreatment unit where I covered the classification of animals without robust intervention. Two consecutive one-week long treatment units followed this nontreatment unit. The solar system was covered in the first treatment unit and the water cycle in the second treatment unit.

This project started with a nontreatment unit where I taught my students about the classification of animals. This unit introduced them to ideas and vocabulary that they had not previously encountered. Before this unit started, students were given a preunit science assessment that addressed the different levels of Bloom's taxonomy. The assessment also included an area to draw a picture of what they knew to assess their comfort level and foreknowledge of the material (Angelo & Cross, 1993). The preunit assessment may be found in Appendix A. In addition, students were also given a preunit English spelling quiz with unit-related vocabulary. The preunit English assessment may be found in Appendix B.

Using the results of the preunit assessments, I tried to determine how cognitively complex their understanding of the material was. In addition to these assessments, students were given preunit interviews, as well as preunit surveys. The interview and survey may be found in Appendices C and D, respectively. I then implemented my instruction of the unit by using class explanations and example problems that dealt with placing different organisms into categories of classification based on their traits. Students were given a unit worksheet to aid them in learning. A copy of this worksheet may be found in Appendix E. A sample of a nontreatment lesson may be found in Appendix F. After the implementation, students were given a postunit science assessment, a postunit English assessment, and a postunit interview. These instruments may be found in Appendices G, B, and H, respectively. In addition, students were given a postunit survey (Appendix D). Two weeks after the end of this unit, students were given delayed unit science and English assessments (Appendices G and B).

The first treatment unit dealt with introducing the students to the solar system. To start, I gave my students a preunit survey (Appendix D) and a preunit science assessment (Appendix I) to assess their comfort level and foreknowledge of the material (Angelo & Cross, 1993). In addition, my students were given a unit-related preunit English vocabulary assessment. This assessment may be found in Appendix J. After collecting the data from these preunit assessments, they were analyzed and the results were shared with my students to close the feedback loop of understanding before beginning my instruction of the unit. I showed them what they seemed to know well and what they did not seem to know well. I also told them that I would teach them about both topics so that they would have a better understanding of them in the future. I then modified my lesson plans to incorporate more time with the material that they did not know as well and implemented my instruction by using a hands-on activity to explain the solar system. Other activities related to targeted, real-world, current events were then implemented.

In addition to the hands-on activities, I found pictures of the solar system, astronauts and spaceships to show my students how knowledge of the solar system is applicable to real-life scenarios. A sample of a treatment lesson may be found in Appendix K. In addition to these media, I used a unit worksheet to aide the students' learning. A copy of this worksheet may be found in Appendix L. Six students, which were selected based on their performance on previous evaluations, were also interviewed both before and after the intervention (Appendices C and H). They were given a student attitude survey (Appendix D), as well as postunit science and English assessments. The postunit science and English assessments may be found in Appendices M and J. Two weeks after the end of this unit, students were given delayed unit science and English assessments (Appendices M and J).

The second treatment unit dealt with introducing the students to the water cycle. Before this unit started, students were given a preunit science assessment. This preunit science assessment may be found in Appendix N. A preunit unit-related English spelling assessment was also given. This assessment may be found in Appendix O. The same preunit and postunit interview questions were used for the second treatment unit (Appendices C and H). In addition, the same student attitude survey was used (Appendix D). A procedure similar to the first treatment section was used, which also involved using hands-on activities and current events that allowed me to document the changes in understanding between my students' pre and posttreatment unit assessments. In addition, a student worksheet was used to aid the students. This worksheet may be found in Appendix P. The postunit science and English assessments may be found in Appendices Q and O, respectively. Two weeks after the end of this unit, students were then given delayed unit science and English assessments (Appendices Q and O).

An example of a hands-on activity I used in class is the one I used to teach the solar system. In it, I separated the class into groups of three or four students. Each group was given a variety of pre-painted foam balls, each representing a planet, the sun, or a comet, and a set of wooden sticks. Then, I instructed them to use the wooden sticks to connect the sun to the planets, making sure to put the planets' orbits progressively farther from the sun in the proper order. When they finished, I had them show me their work and then I asked each of them to point to each celestial body and say its name. A sample of this treatment lesson is found in Appendix K.

Another example of a hands-on activity I used in class was used to teach the water cycle. At the start of the lesson, I had each student put his or her water bottle in the school's refrigerator. While his or her water bottles were chilling, I had each student sit around my desk in a circle. I heated up a hotplate on the desk and used it to boil some water in a pot. As the water boiled, I placed a lid over the water. When I removed the lid, there was condensation on the underside of the lid. I used this to demonstrate evaporation, condensation, and then precipitation and collection, as the water fell back off the lid and into the pot. After this activity, I brought the students' water bottles back into the room and gave them back to the students. I told them watch them as they collected water on the outside. I then proceeded to ask them why they thought the water collected on the outside of their bottles, and then explained that it was condensation because the temperature was lower around the bottle and the air could not hold the same amount of water.

Hands-on activities will hold students' attention for a longer amount of time, and they will put a concept into a medium that can be visualized. Due to this, the treatment should be more effective at helping students augment their attitudes toward the sciences and understand key scientific concepts. This should cause the concepts to solidify strongly in the students' minds and they would have understood the scientific concepts on a more fundamental level.

Data Collection Instruments

I taught one class of 13 first-grade ESL students, ages six and seven, at the Hugokids Kindergarten and Language School in Chiayi City, Taiwan. Most of the students came from upper-middle class or upper class backgrounds. All of the students were Taiwanese citizens of Han Chinese descent, and all had grown up in Chiayi City. Chiayi City is a small city with a population of roughly 280,000. It lies in the southwestern portion of the island.

The curriculum for this first-grade class included a yearlong introduction to English reading. Some of the underlying themes were grammar, phonics, reading, and sentence formation. I chose to use this class for my project because there are enough students to have an adequate sample size so that the data would be indicative of larger trends. I also happened to spend more time with this class in a week than with any of my other classes, allowing for more time to implement my project. Last, I chose this class because it contained a mixture of high, middle, and low-achieving students. This way, I was able to study the effects of my intervention from multiple perspectives.

Data were collected for each of my project questions to allow for triangulation. These data were compiled into Table 1. Table 1 illustrates the use of these methods of data collection allowing me to view my classroom situation from a variety of perspectives so that I could get a better overall view of the situation

Table1
Triangulation Matrix of Data Sources by Project Question

Project Questions	Data Source		
What are the effects of using formative assessments with targeted real world, current events and hands-on activities on students' abilities to understand scientific concepts?	Pre and postunit assessments and observations with an observation sheet [I read it with assistance from my bilingual co-teacher]	Pre and postunit student interviews	Pre and posttreatment student surveys
What are the effects of using formative assessments with targeted real world, current events and hands-on activities on students' enthusiasm for learning about science?	Instructor field observations	Pre and posttreatment student interviews	Pre and posttreatment student attitude surveys [I read it with assistance from my bilingual co-teacher]
What are the effects of using formative assessments with targeted real world, current events and hands-on activities on students' long-term memory of scientific concepts?	Post and delayed unit assessments with each unit; assessments and observations with an observation sheet [I read it with assistance from my bilingual co-teacher]	Post and delayed unit student interviews with each unit	Post and delayed unit student surveys with each unit
What are the effects of using formative assessments with targeted real world, current events and hands-on activities on my attitude as a teacher towards my students?	My daily teaching journal entries written throughout the project with prompts	Pre and posttreatment teacher attitude survey	Nontreatment and treatment observations by colleagues

I used science assessments covering the different levels of Bloom's taxonomy for the preunit, postunit, and delayed science assessments. In addition, I used student surveys to gauge the students' attitudes both before and throughout the intervention. In addition to the surveys, preunit, postunit, and delayed student interviews were given to six students. Each time I conducted interviews, I took one student aside at the end of each class for several minutes. Over the course of each unit, I was able to interview six students. I had two high, two middle, and two low-achieving students. The students were assigned to different achievement groups based on my prior observation of each student, and on their prior assessment scores. I used pseudonyms to identify each student. Students A and B were high-achieving students. They displayed few behavioral problems and showed an aptitude for extended concentration. Both of them scored well on their formative and summative assessments. They were both six years old. Students C and D were middle-achieving students. They showed a high mental aptitude, but their lack of concentration hindered their academic progress. I chose them because I thought the difference between nonintervention and intervention would be especially vivid because hands-on activities tend to hold students' concentration better than traditional teaching methods. Both of them were six years old. Students E and F were low-achieving students. They displayed more behavioral problems than the other students I chose to interview and they both found it difficult to concentrate. In addition, they tended to pick up concepts slowly.

Regarding my students' limited ability to use English, my bilingual (English and Mandarin Chinese) co-teacher helped explain in Chinese what I was trying to explain in

English when we ran into areas of confusion. She was also instrumental in translating some of the more elusive interview and survey questions. A copy of my interview questions can be found in Appendices C and H. In addition to these selective interviews, I gave all my students pre and postunit attitude surveys. A copy of this survey can be found in Appendix D. In addition to these methods of collecting data, I also kept a personal journal of my experiences during the project where I reflected on my attitudes, realizations, and observations. Furthermore, I gave myself pre and postunit attitude surveys, and enlisted the help of colleagues to provide me with observations during the unit. The field observations prompts, teacher attitude survey, and journal prompts are located in Appendices R, S, and T, respectively. The teacher observation prompts provided to my colleague are located in Appendix U. A letter showing the school administrator's consent can be found in Appendix V, and a timeline for the entire project is provided in Appendix W.

DATA AND ANALYSIS

The data was compared from one nontreatment unit and two treatment units. These data helped answer the four focus questions that comprised this research.

The first focus question regarded students' understanding of scientific concepts in an ELL environment. The data collected from the pre and postunit science assessments allowed me to calculate percentages of change in students' understanding of the material covered in the unit. The scores retrieved from these assessments and the subsequent calculations can be found in Table 2. Students showed much improvement in their knowledge after each unit was taught, but the normalized gains indicate the preassessment scores might have been a factor in the actual changes.

Table 2
Mean Scores of Preunit and Postunit Science Assessments (N=13)

Unit Data	Nontreatment Unit	Treatment Unit 1	Treatment Unit 2
Preunit Assessment	14.2	1.3	3.8
Postunit Assessment	39.9	40.2	24.4
Percentage Change (%)	181.9	3031.8	543.1
Normalized Gain	0.30	0.39	0.21

Note. All scores are taken out of 100.

As is evident, students had some knowledge about the classification of animals (nontreatment unit) before the unit was started; however, afterwards, students performed much better. This same trend holds true for the treatment units. Before the treatment units, students had little understanding of the solar system (treatment unit 1) and the water cycle (treatment unit 2), but they gained this knowledge in light of the intervention. The normalized gain for the first treatment unit is somewhat higher than for the nontreatment unit. However, the normalized gain for the second treatment unit is lower than that for the nontreatment unit. Therefore, there is no discernable trend between the intervention that was used and an increase in students' understanding.

In addition, data were collected about students' competency in English. These data concerned the students' ability to understand how to spell unit-related vocabulary. These data are displayed in Table 3.

Table 3
Mean Scores of Preunit and Postunit English Assessments (N=13)

Unit Data	Nontreatment Unit	Treatment Unit 1	Treatment Unit 2
Preunit Assessment	10.6	15.4	13.1
Postunit Assessment	19.8	45.5	29.2
Percentage Change (%)	87.1	195.5	123.5
Normalized Gain	0.10	0.36	0.19

Note. All scores are taken out of 100.

The data show a clear correlation that students' were better able to spell unit-specific English words after the treatment units than before it. The percentage change between the preunit scores and the postunit scores were higher for the two treatment units than for the nontreatment unit. In addition, the normalized gain scores were also higher for the two treatment units. This indicates that students acquired a better understanding of how to spell unit-related English vocabulary.

In addition to preunit and postunit assessments, preunit and postunit student interviews were also used to gauge the understanding the students had of their ability to understand scientific concepts. The quantitative data from these interviews can be found in Figure 1.

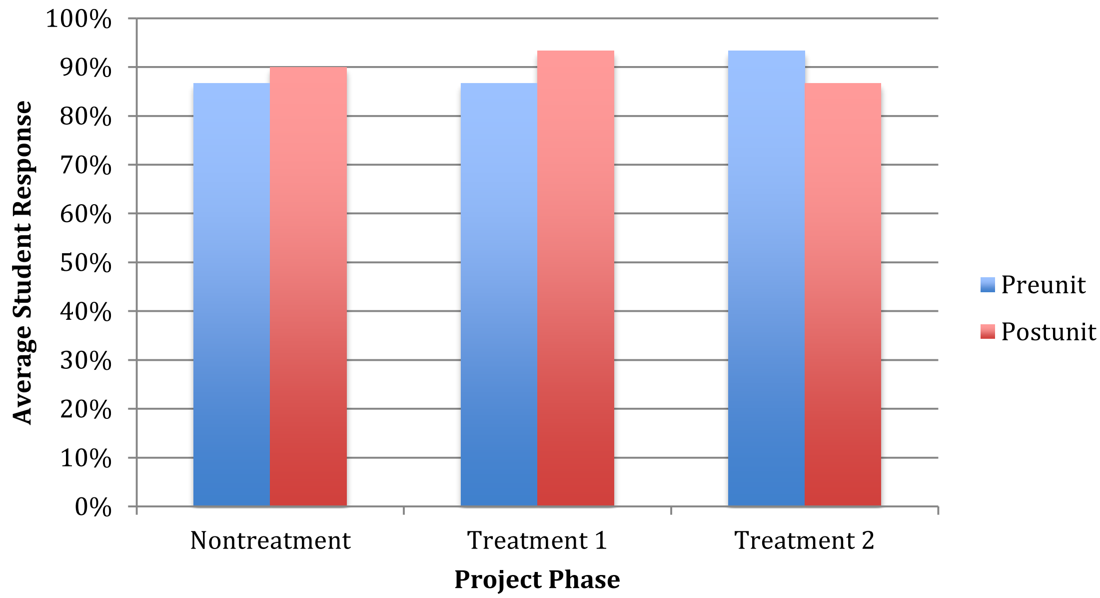

Figure 1. Average student response to the interview question regarding how well they understood, (*N*=6).

In both the nontreatment unit and the first treatment unit, students claimed to have understood more after the unit than before it. However, the opposite was true for the second treatment unit.

My observations in my journal indicated that the nontreatment unit showed less of an increase in the students' perceived retention than in the first treatment unit because students already knew a fair amount about animals, which was the topic of the nontreatment unit. However, as I wrote in my journal, they seemed to know less about the solar system. This could explain some of the differences between the preunit and postunit interview results. Many students mentioned in class that they had previously studied the water cycle, the subject of the second treatment unit, in their regular Chinese schools. Many of them went into the unit confident in their own abilities. My journal comments indicated that they found the material, especially the longer-than-average English words, more challenging than they had imagined.

In addition to the assessments and interviews, preunit and postunit surveys were given to each student. The results of the quantitative data can be found in Figure 2, regarding the question about how well they understood the material.

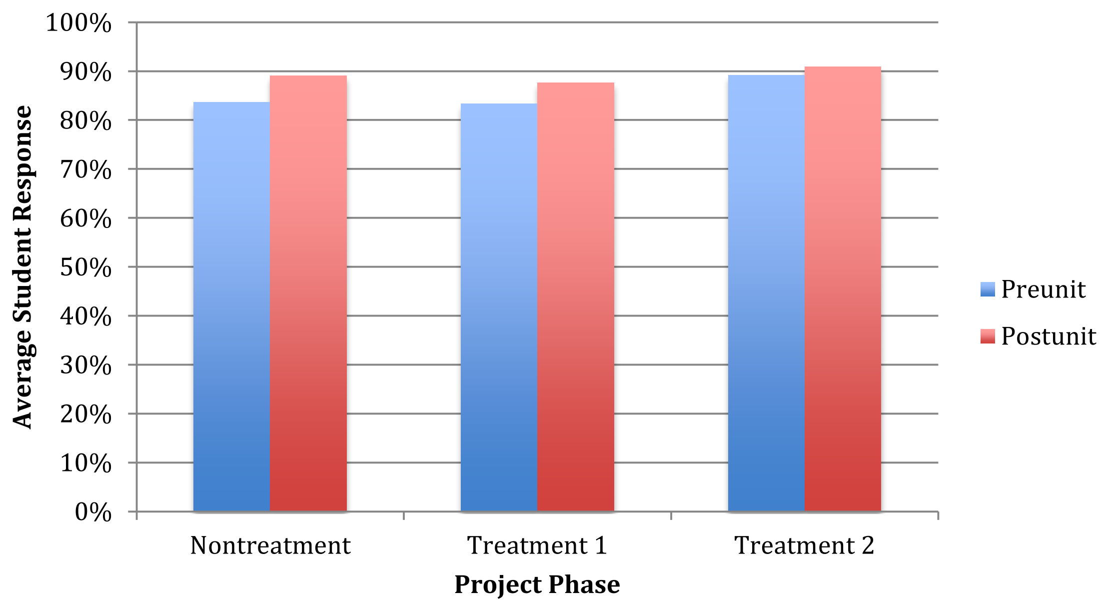

Figure 2. Average student response to the survey question concerning their perception of how well they understood the material, (*N*=13).

Students showed an increase, at least somewhat, in their perception of understanding of the material across all three units. However, the largest increase was in the nontreatment unit. Many students spoke of how much they already knew about the water cycle. This could have led to a sense of overconfidence, thus causing the higher responses. If this were true, it would help explain the smaller difference between the preunit and postunit results for the second treatment unit than for the nontreatment unit and the first treatment unit.

The second project question regarded students' enthusiasm for learning about science. This question was triangulated using instructor field observations, preunit and post unit student interviews, and preunit and postunit student attitude surveys.

While making field observations, I ranked student enthusiasm. These data can be found in Figure 3.

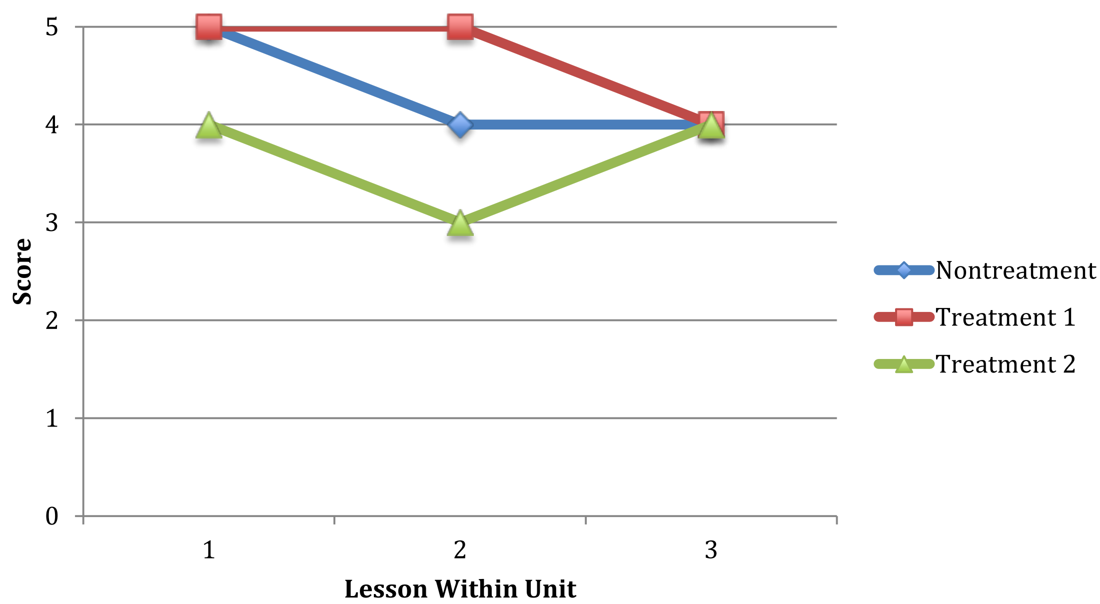

Figure 3. Average teacher field observation responses to the field observation question concerning how motivated the students seemed on that day concerning the overall class. *Note.* 5 = Highly Motivated, 4 = Motivated Above Average, 3 = Moderately Motivated, 2 = Motivated Below Average, 1 = Barely Motivated.

The data show that during the nontreatment unit, students were highly motivated for the first lesson. The students lost some of their initial motivation during the subsequent two lessons, but were generally highly motivated. During the first treatment unit, students were highly motivated for the first two lessons. Then, the third lesson showed that they were motivated above average, but had lost some motivation compared with the first two lessons. The second treatment unit started with students being less motivated than they had been at the beginnings of the other two units. The subsequent lesson saw that they were less motivated than the first, but they regained some motivation during the last lesson.

The high level of student motivation seen at the beginning of the nontreatment unit is because the students were initially very excited to study something they had never studied before. The class's anticipation of the lessons was quite high. Then, their excitement lowered as the initial anticipation wore off and the reality of what they were doing set in. Regarding the first treatment unit, the students were very excited because they were promised a robust intervention that included fun and educational hands-on activities and current events. The students enjoyed the activities and current events very much, and stayed enthused throughout the second lesson. The students were less enthused during the third lesson, but were still highly interested. Regarding the second treatment unit, the students began with less enthusiasm than they did during the other two units. The students' enthusiasm, however, decreased during the second lesson. They were already familiar with the material to a significant enough extent that they lacked interest in repeating it. In addition, while there were hands-on activities and current events, they did not appear to be perceived as quite as fun as they had during the first treatment unit. However, despite their moderate enthusiasm during the second lesson, they gained a little during their final lesson.

Considering the qualitative data from my observations, I wrote during the first lesson on the nontreatment unit that, "The students seemed very eager to begin learning about science. They were incredibly energetic." During the second lesson, I commented that, "The students were not as eager as they were during the last lesson. However, they still seemed enthused and attentive. Many students were still keen to answer questions and participate willingly." During the third lesson, I commented that, "Student participation was on par with the second lesson in this unit. Students seemed to absorb the key differences between the animal classes, and this added to their confidence, but their enthusiasm was still not as high as it was during their first lesson."

During the first treatment unit, I commented that, "Student enthusiasm was incredibly high. They were very eager to do the hands-on activity for the class and learn about the current events. However, when the students started the hands-on activity, there was a lot of argumentation about who would get to participate more." During the second lesson in the unit I commented that, "The students seemed very intrigued by space. They asked many questions." Regarding the third lesson I noted that, "The students seemed to feel more confident in their ability to understand space and the concepts regarding it. However, their enthusiasm was somewhat diminished from its previous levels."

During the second lesson in the second treatment unit, I wrote that, "The students seemed more ambivalent than they had in any previous lesson. They still answered questions, but it was hard getting them to participate I noted that, "Many students didn't seem as enthused as they did during the other two units. When the topic of the water cycle was mentioned and a cursory overview of it was explained, many students told me that they already learned about it in their Chinese schools. However, students were still attentive and willing to participate as actively and enthusiastically as they had during the other lessons." During the third lesson I noted that, "The students seemed to really understand the water cycle well. They also seemed to regain some of the enthusiasm that they had lost during the previous unit."

In addition to my field observations, interviews were given to students both before and after the units. Two questions were asked that yielded quantitative data. The first question concerned how excited they were about learning, and the second concerned, how much they liked science. The data for the first question can be found in Figure 4.

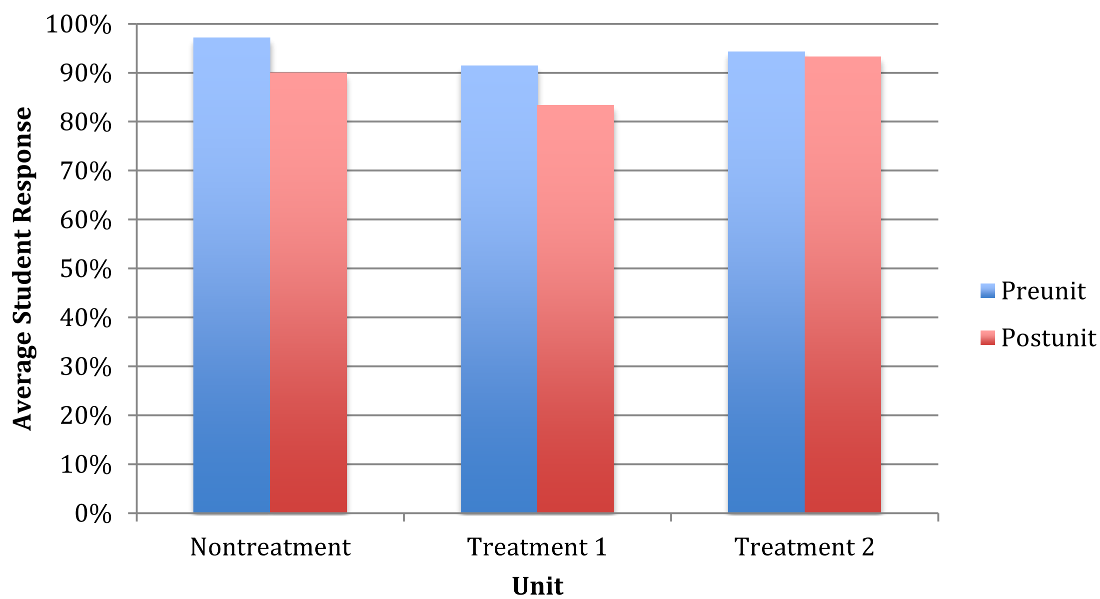

Figure 4. Average student responses to the interview question concerning the students' excitement about learning, (*N*=6).

The average student excitement decreased from the preunit to the postunit interviews across all three units. This may be because the students were more excited with the anticipation of an unknown subject, and once known, lost that anticipatory excitement. Despite my field observations where I noted that students seemed the least enthused during the second treatment unit, the students voted very highly when asked how excited they were about learning. In addition, the scores were lowest for the first treatment unit, the same unit that I saw the most enthusiasm in. This lowness may be due to the fact that the sample population was relatively small (*N*=6). Perhaps students felt more pressured to give positive answers when confronted face-to-face, as opposed to anonymously, despite my telling them that nothing they said or divulged would be used against them in any way if they chose to participate.

Quantitative data regarding the second question concerning how much the students like science can be found in Figure 5.

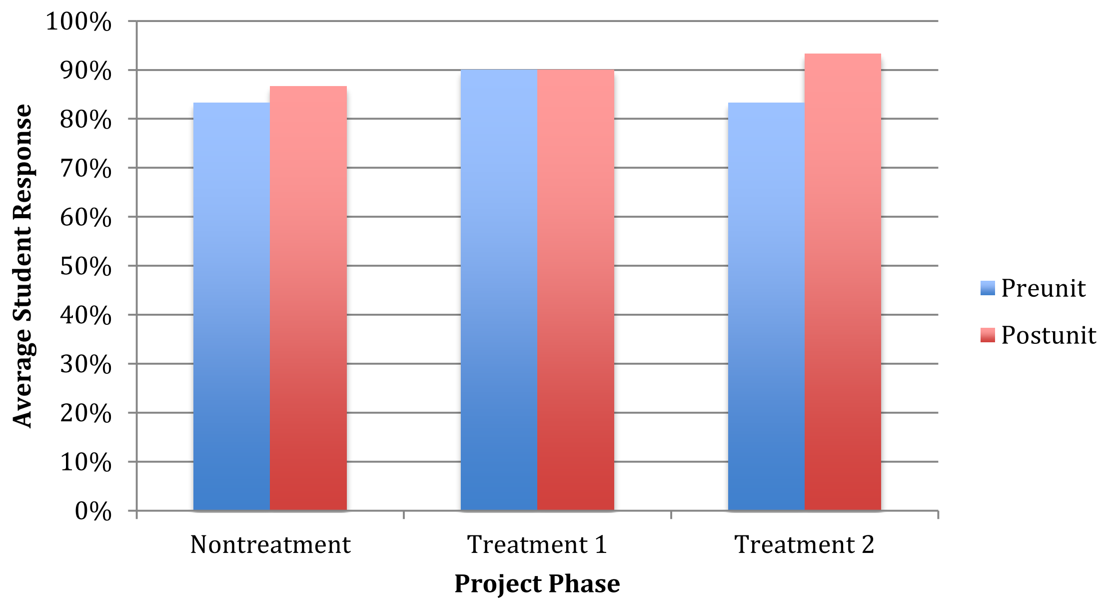

Figure 5. Average student response to the interview question concerning how much they like science, (*N*=6)

Interestingly, the responses to the question detailed in Figure 5 became more positive between preunit and postunit responses for the nontreatment unit and the second treatment unit. They were unchanged for the first treatment unit. These increases may have come from an increase in the understanding of science and what sort of things lay within its scope. The 12% increase between the preunit and postunit interviews regarding the second treatment unit is larger than the discrepancy between the preunit and postunit interviews for the other two units. I mentioned in my teaching observations that students seemed less enthused during this unit. However, there was a substantial increase in the positivity of the students' responses. This may, again, be due to the relatively small sample size.

Concerning the qualitative data gathered from the interviews, students mostly gave simple answers that were very content specific. For example, during the nontreatment unit, when asked what he or she liked best, students responded with a variety of answers. One student said, "Reptiles, because I like reptiles." Another student said, "I like arthropods, because they're interesting." When asked what he or she didn't like, some students gave some surprising answers. For example, one student claimed, "I didn't like the picture of frogs on the branch because the frogs were red." Yet another student said, "I don't like Mercury because it's so hot." The students' like and dislike of the material came from very specific points of view. Instead of thinking to themselves as liking an entire area of study (e.g. animal classification, the solar system, or the water cycle), students seem to differentiate what they like and don't like based on very specific characteristics. For example, they may like some animals and not others, making them like or dislike the area of biology, or they may prefer some planets to others causing them to like or dislike astronomy. This could shed some light on the seemingly conflicting data found between my field observations, one of the student interview questions, and the other question. Perhaps some students rated areas of study based more on their like or dislike of particular things within the lessons themselves rather than on their perception of the entire area of study. This would serve to explain some of the discrepancies that have been noted.

In addition to the student interviews, preunit and postunit student attitude surveys were conducted. In these surveys, two questions were asked that were pertinent to answering my focus question regarding student enthusiasm. The quantitative results of these survey data for the nontreatment unit, first treatment unit, and second treatment unit for the first question can be found in Figure 6.

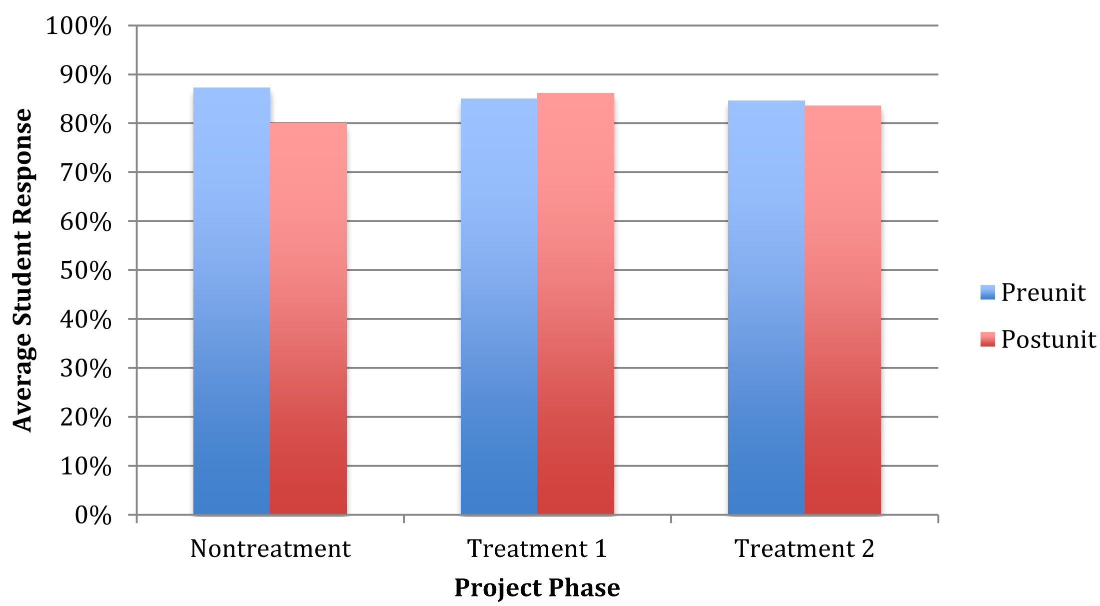

Figure 6. Average student response to the survey question concerning how much they like science, (*N*=13).

Student enthusiasm decreased between the preunit and postunit surveys for the nontreatment unit and the second treatment unit. In contrast, the student responses increased for the first treatment unit. This may be partially explained by the students' remarkable enthusiasm during the first treatment unit. These data are more in line with my observations about student enthusiasm. In addition, the sample population encompasses the entire class, minus any absent students.

The results from the second question concerning how much the students wanted to learn more may be seen in Figure 7.

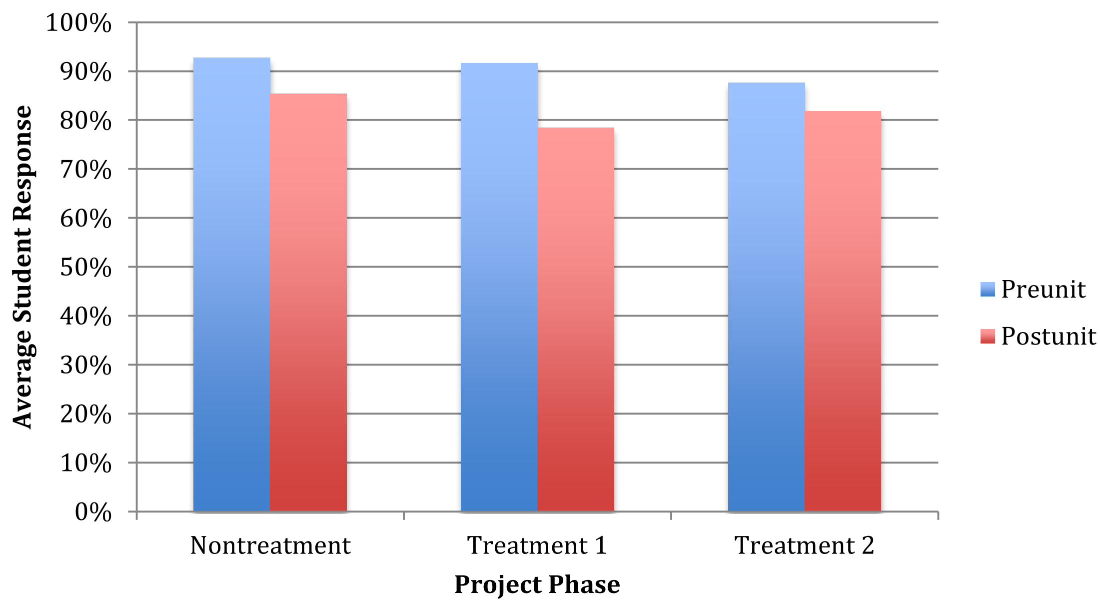

Figure 7. Average student response to the survey question concerning how much they wanted to learn more, (*N*=13).

Interestingly, student responses to this question became more negative across the board for all three units. This is in line with my field observations about student enthusiasm. With the exception of the second treatment unit, all the units showed a decrease in motivation and excitement between the preunit and the postunit. In my observations, the second treatment unit showed a consistent amount of enthusiasm from the first to the last lesson in the unit. In these surveys, the second treatment unit also had the smallest difference between the preunit and postunit responses. These data, collected from a more representative sample population, accurately corroborate the data I found in my field observations.

Regarding qualitative data, students responded to several open-ended questions on these surveys. However, since surveys were anonymous, fewer student-teacher interactions occurred, and the detail the students were able to convey in their responses was marginalized. However, a few notable quotes emerged. One student, in response to the question concerning what he or she liked best answered, “mammals.” Another, during the second treatment unit wrote, “sun.” In similar fashion to the interviews, the students seemed to gravitate towards the specifics of the content rather than the general ideas. When asked what they wanted to do more of, one student wrote, “play games.” This shows an inclination to do something more interactive rather than rote.

The third project question regarded students’ abilities to retain the knowledge they had acquired for an extended amount of time. This question was triangulated using postunit and delayed unit assessments, postunit and delayed unit student interviews, and postunit and delayed unit student surveys.

The results of the postunit and delayed unit assessments can be found in Table 4.

Table 4
Mean Scores of Postunit and Delayed Science Assessments (N=13)

Unit Data	Nontreatment Unit	Treatment Unit 1	Treatment Unit 2
Postunit Assessment	39.9	40.2	24.4
Delayed Assessment	33.3	32.1	21.8
Percentage Change (%)	-16.5	-20.2	-10.5
Normalized Gain	-0.11	-0.14	-0.03

Note. All scores are taken out of 100.

As is evident, students showed a decrease in retention of the material between the postunit assessments and the delayed assessment. However, unlike the data regarding the preunit and postunit assessment comparisons, the postunit and delayed assessment comparisons show no pattern between the nontreatment unit and the treatment units. While the data clearly show that robust interactive interventions have a positive correlation with higher rates of comprehension, they do not seem to be at all correlated to the students' abilities to retain what they have learned for any length of time.

In addition to collecting data regarding students' retention of scientific concepts, I collected data about their retention of content-specific English vocabulary. These data can be found in Table 5.

Table 5
Mean Scores of Postunit and Delayed English Assessments (N=13)

Unit Data	Nontreatment Unit	Treatment Unit 1	Treatment Unit 2
Postunit Assessment	19.8	45.5	29.2
Delayed Assessment	16.8	33.5	23.1
Percentage Change (%)	-15.0	-26.4	-21.1
Normalized Gain	-0.4	-0.22	-0.09

Note. All scores are taken out of 100.

These data show that there is no correlation between students' ability to retain what they've learned and the type of intervention used.

In addition to assessing their English competency, data were collected from postunit and delayed student interviews. The students were asked how well they understood the topics being taught. These data can be found in Figure 8.

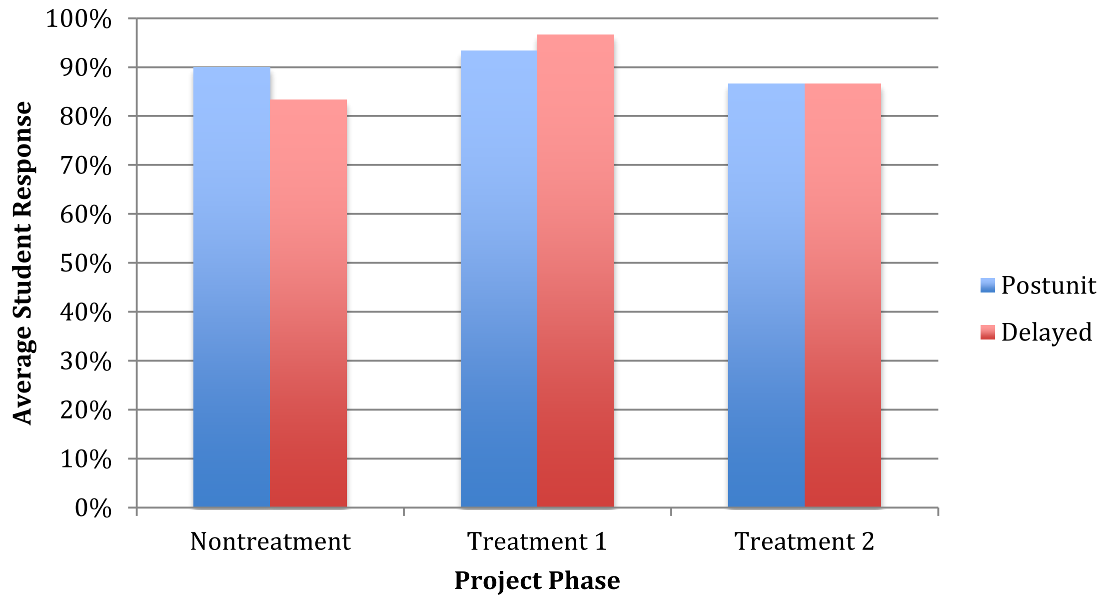

Figure 8. Average student responses to the interview question regarding how well they understood, (*N*=6).

Students' responses decreased from the postunit to the delayed interview for the nontreatment unit. However, students' responses increased during the same interval for the first treatment unit by 3.6%. Students' responses stayed consistent for the second treatment unit. One reason that these data may not show a definitive trend was that there was a considerable amount of time, two weeks, between the postunit interview and the delayed interview. Therefore, students may have forgotten their previous thoughts or answers and not answered as accurately as an assessment would have shown. In addition, the sample population was small.

In addition to student interviews, student surveys were also given at postunit and delayed intervals. These surveys yielded quantitative data from two questions. The first question was regarded how well they understood. These data can be found in Figure 9.

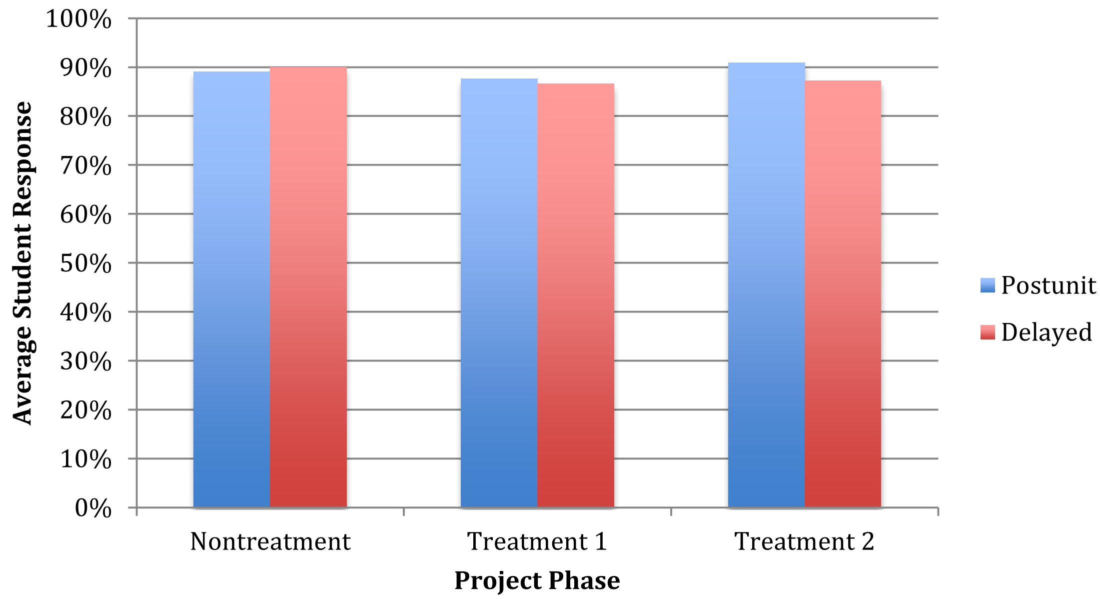

Figure 9. Average student response to the survey question regarding how well students understood, (*N*=13).

Student responses became slightly more positive during the nontreatment unit. Student responses decreased slightly during the first and second treatment units. These data seem to fit the trends of my observations more accurately. They show that students still felt very confident in their abilities to understand animal classification after a two-week delay. As was previously stated, the students already felt a degree of comfort with animals, so it's not surprising that their responses would be similar. Students still felt confident in their abilities, but their confidence had diminished over a period of time. These data were also more accurate, likely due to the larger sample size.

Students were also asked a question regarding how well they remembered this material. The quantitative data from this question can be found in Figure 10.

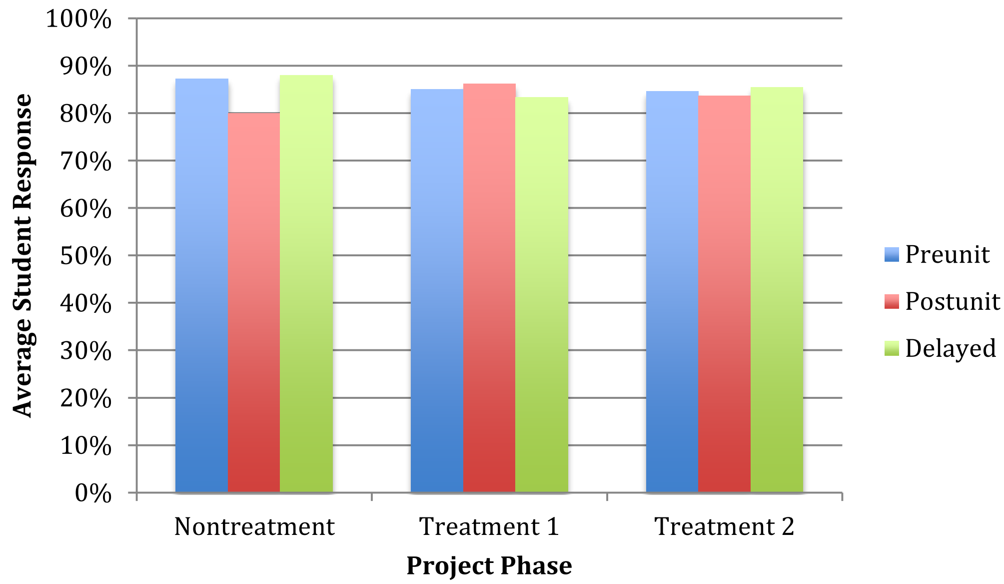

Figure 10. Average student response to the survey question concerning how well they would remember this material, (*N*=13).

Another reason for this drastic increase could be that the students were taken out of the context of the unit when they answered it. For example, when they filled in the survey immediately following the unit, they were likely thinking of the unit's material. After a two-week lapse, however, they were reminded that the unit was about animals, and perhaps they thought of only animals in general instead of how they're classified. The first treatment unit yielded data that's in line with the student assessments. The responses at the delayed interval were only slightly lower than what they were at the postunit interval. However, the second treatment unit showed an increase between the two intervals. This may be explained because the students previously told me that they learned about the data water cycle in their Chinese schools. Perhaps their confidence increased over the two-week data collection period, or perhaps they remembered it differently after two weeks than they did just after the unit.

The fourth focus question concerned studying my attitudes and motivations as a teacher. This question was triangulated with a daily teaching journal, pre and posttreatment teacher attitude surveys, and nontreatment and treatment observations by colleagues.

Daily journal entries were written with particular prompts as guides. Throughout the course of this research, my attitudes remained positive. Initially, the undertaking was stressful. I had to get my students used to a new method of doing things because the science curriculum was outside of our normal curriculum. Its procedures and material were far different than our normal curriculum, which created a bit of difficulty dealing with the rapid adaptations that had to take place. I found the first unit, the nontreatment unit, enjoyable to teach. This unit was about animal classification. I noted in my journal that it was a perfect way to segue into teaching science to ESL students because if there's any scientific vocabulary that ESL students know, it's animals. I also noted that the students were excited and I found it enjoyable to watch their transformations and see them make discoveries on their own.

The first treatment unit, which dealt with the solar system, was a bit more stressful. The hands-on activities, such as the building of a model solar system, were met with a lot of enthusiasm and anticipation. However, this also posed some challenges. These students, who are usually well mannered, were much harder to control because their enthusiasm excited them too much. I found it difficult to convey the instructions for the assignment, and it took a few tries to get everyone to pay attention so that they would know what to do. In this regard, teaching this unit was more stressful than the nontreatment unit; however, it was also fun and rewarding. After we passed the few initial hurdles, the class started to come together and really get into the projects. They also enjoyed hearing about some current events, like the recent meteor shower in Russia. They were also shown the video of Neil Armstrong taking his first steps on the moon. The students were inspired and had many questions. So, contrary to my other experiences with this unit, this part was very rewarding and helped drive my motivation.

The second treatment unit, which dealt with the water cycle, was the most difficult to teach. The words associated with it (e.g. evaporation, condensation, etc.) are longer and harder to remember than the simpler English words associated with the other lessons. This made teaching these words to an ESL class all the more challenging. The students were curious about the topic, but not as curious as they were with the other two units. For example, many students said they had already learned about the water cycle in their Chinese schools. They knew what was going on, and for them it was basically a way to teach them more complex vocabulary. I saw this lack of interest in some, but not all, of the students. It was somewhat disheartening. As a teacher, I thrive off of the enthusiasm from my students, so it was somewhat difficult to stay enthused after seeing their reactions to the lessons. The hands-on activities and current events were well received. There were also some observational activities. For example, I boiled water on a hot plate and then held that pot's cover over it to collect the condensation.

Of the three units, the first treatment unit was the most inspiring and fun to teach. It's success more than overshadowed the initial frustrations. After that, the nontreatment unit was the most interesting. I was not sure that would be the case before I implemented it, but I was pleasantly surprised at the enthusiastic responses I got. The least motivating of the three was the second treatment unit. I found it difficult to stay motivated or to encourage students to ask more meaningful and farther-reaching questions.

In addition to studying my own attitudes and motivations as a teacher, I had one of my colleagues observe 20-minute segments of three different lessons: one nontreatment lesson, one treatment lesson from unit 1, and one treatment lesson from unit 2. During the nontreatment unit, my colleague commented that, “While I observed you and your students, I noticed they were very engaged in the class. They enjoyed the lesson about animals and the different pictures that you showed them. You were very motivated to teach them.”

During the first treatment unit, my colleague commented that, “The students were very excited by the solar system activity, but I noticed many more instances of the students being distracted and not paying as much attention to the lesson. You were motivated to teach them, but seemed more discouraged.” Similarly, my colleague commented on his observation of a lesson from treatment unit 2 that, “The students were very excited and eager to participate in the class activity. Sometimes, they were so eager that they didn’t pay attention as well to the class. You were highly motivated to teach them, but you seemed a little distracted with some students’ behavior.”

In addition to writing a teaching journal and having my colleague critique my teaching, I took a pre and posttreatment teacher attitude survey. The quantitative data from these surveys can be found in Figure 11.

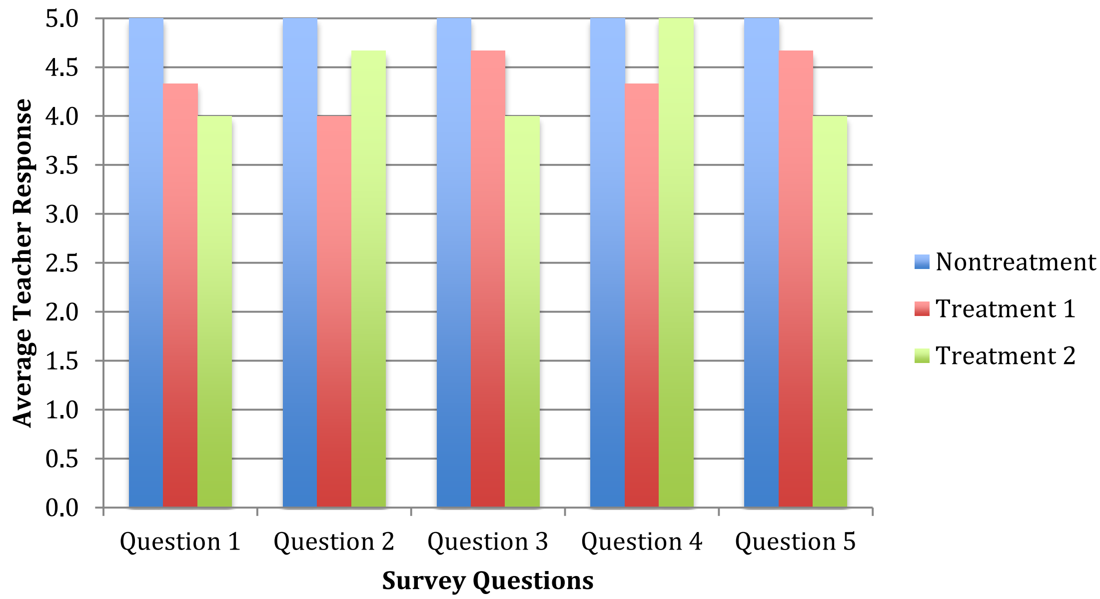

Figure 11. Average teacher response to five survey questions. Question 1: How enthused are you to continue in this way? Question 2: How much energy do you have to continue at this same pace? Question 3: How motivated are you to develop similar lessons? Question 4: What is your impression of the students' retention? Question 5: How motivated are you to continue action research? (*N*=1)

Regarding the first question about my enthusiasm, my enthusiasm decreased evenly from the nontreatment unit through the second treatment unit. This has to do with the initial excitement I felt starting my project. Throughout the units, I started to lose enthusiasm as the workload of the project started to take a toll on me. This was especially true after the students' ambivalent reaction to the second treatment unit. Regarding the second question about my energy to continue at the same pace, I started with a lot of energy. My energy then decreased during the first treatment unit, and reemerged during the second treatment unit. The hands-on activities took a lot of effort to prepare, and implementing them was difficult because I had to deal with student contesting their right to participate more than their classmates in the class. Then, since I had already prepared all the activities during the first treatment unit, I regained energy during the second treatment unit. Regarding the third question about my motivation to develop similar lessons, my motivations decreased from the nontreatment unit through the second treatment unit. I was initially exuberant. As the realities of the workload set in, my motivation decreased throughout the course of the research. Regarding the fourth question about my impression of students' ability to retain what I had taught them, I selected a 5 for the first lesson of the nontreatment unit. Then, my answers became more negative, and then became more positive yet again. This was because the students were very motivated during the nontreatment unit, as was I. They already had some background knowledge about animals, and this helped them develop a better understanding of the material.

During the first treatment unit, students really seemed to latch onto the material, but they were initially more confused than they were during the nontreatment unit. I saw a reemergence of understanding during the second treatment unit. This was because many students already knew about the water cycle from their Chinese schools. Regarding the last question about my motivation to continue doing action research, my answers decreased from the nontreatment unit through the second treatment unit. This was because I gradually became more fatigued as I conducted this research. It took a lot of dynamism to complete, and I gradually was drained of energy and motivation to continue it in the future. Now that I am not in the midst of delivering the lesson, however, I feel a resurgence of motivation to do more action research in the future.

INTERPRETATION AND CONCLUSION

The goal of this project was to determine how well using formative assessments with targeted real-world, current events and hands-on activities affected students' abilities to understand scientific concepts. Furthermore, the students' ability to maintain their enthusiasm for learning about science, their ability to retain what they have learned for an extended amount of time, and how this type of intervention affects my attitudes as a teacher were also studied.

One of the purposes of this research was to understand how the aforementioned intervention would affect students' retention of scientific concepts, both in the immediate sense and for an extended period of time. The data suggest that formative assessments, with targeted real-world, current events and hands-on activities has a positive impact on students' ability to digest and comprehend material, both immediately and over a range or time.

If I had to repeat this experiment, I'd make the survey questions more specific. I would do a better job of specifying the questions and making sure that each student thoroughly understood each question. In addition, I would also increase the sample population of students taking the interview questions. Interviewing six students can give statistically significant data, but more would make any noticeable trends much stronger and give a better picture of what's going on in the class. It's possible that the students, either in their own confusion about the questions or due to something that was lost in translation, misunderstood the exact meaning of the survey questions.

Another thing I would change would be the selection of the content that would be taught in each unit. The data were very widespread. One reason I think this occurred was that the nontreatment unit was devoted to the classification of animals. While the system of classifying animals was new to the students, the concepts and pertinent vocabulary regarding animals was not entirely new. Basic knowledge about animals is one of the first things ELL students are exposed to when they begin to learn English. So, some words and concepts were already familiar to them. For example, ‘fish’ can refer to a particular animal, or an entire class of animals. The same is true for birds. So, students were probably able to deduce that a particular question was referring to either of these two classes, and unknowingly wrote the name of the animal and happened to get it correct. If this is true, then it would also mean that differences between preunit assessment scores and postunit assessment scores are narrower than they would be had the subject matter been something entirely foreign to them, such as it was with the two treatment units.

In addition to those changes, I would have added more student interviews to get more statistically reliable results. I would also have been sure to clarify each question on the student survey so that every student would have the same idea in mind during the postunit survey as they did during the delayed survey. Since the students were voting on the quantitative data using a Likert scale from one to five, a single student changing their answer by one or two points can have a significant impact on the trends noticed. I would try to interview at least nine students in the future. The last change I would make would be in my delivery of the surveys. Since the surveys were taken anonymously, I had to explain to the class what was required of them to answer each question. Since English is their second language, it would have benefited the research if very detailed explanations were given. It is possible that some students were thinking of the topic in question in general instead of how well they remember the specific lessons taught within the confines of the project.

Regarding the study of their motivations, the data suggest that students' motivation is more immediate, rather than fixated on a long-term goal. For example, if students are presented with an opportunity to learn about something with an engaging hands-on activity, they will be enthused about the activity more than about the subject matter enveloping it. Therefore, these activities do increase students' motivations, and this is apparent in their increased assessment scores. If I had to do this again, I would make the hands-on activities individual projects instead of group projects. Since the nontreatment unit is taken on individually, I think more accurate data would manifest from individually undertaken hands-on activities. This would also help to increase my motivations as a teacher so that they would be more consistent from unit to unit, which would help give a consistent type of teaching in the classroom. Changing the number of students interviewed from six to nine would give more verifiable data, while still being a small enough group to easily manage. The data were not conclusive enough because of the smaller sample size. I would also more thoroughly explain the questions on the survey to get more accurate data.

The last question this research studied regarded my attitudes and motivations as a teacher. These data were more accurate because I knew exactly what I was looking for and was able to write tailored responses that would allow me to study the specific question. Furthermore, explaining what was required of my colleague was simpler than explaining the instructions to the students. I wouldn't change anything about how I went about collecting this data.

VALUE

This study was very significant for my students and me. It allowed me to see that hands-on activities are very influential in shaping students' enthusiasm towards a particular subject. Young students, such as these six and seven year olds, are motivated more by individual tasks rather than the larger concept of specific scientific sects. For example, students were incredibly motivated to build a model solar system, but no actually to learn about the solar system. They learned about the solar system as a byproduct of their excitement and motivation towards the activity. Therefore, hands-on activities and real-world, current events can be powerful tools used to engage students with topics they otherwise would not be as interested in.

I think this study will encourage me to continue researching hands-on activities and other interactive classroom tools as a productive teaching tool. However, now that it is established that hands-on activities are indeed helpful and foster an increase in students' enthusiasm, the question still lingers, which hands-on activities are helpful and which are not? I am interested in exploring which activities and methods of implementation yield more success at increasing students' enthusiasm, awareness, comprehension, and long-term memory.

The implications of this study are not confined to first-grade ESL students. As other research has shown, and my research augments, hands-on activities can promote a better learning environment where students are more enthused about learning and their motivation increases with that enthusiasm. I think the utilization of hands-on activities could be a catalyst for a new educational wave that could help reshape traditional educational dogma.

One of the most important lessons I have learned about education is the value of foresight and detailed planning. I have realized that the more time I spend preparing for a lesson, the better it is for both my students and me. My motivation is increased when I'm more aware of what I'm doing and what my goals are, and my students are more receptive to lessons with more fluidity.

I also learned much by reflecting on my own experiences as a teacher. I had largely anticipated the outcome of this study, but I had not anticipated everything, specifically the decrease in enthusiasm that was apparent after the hands-on intervention. There are always surprising trends to be found, and I think it's important for me to continue to look for these trends and try to use their data in an unbiased fashion to improve my teaching.

This project enlightened my attitude towards my students. I'm accustomed to engaging them as ESL students, and as a result I have little interaction with them working at their cognitive limits. Teaching them science was eye-opening in the sense that I was able to see them struggle with concepts and become excited once they understood them. It was a fun process.

The most challenging aspect of this project was organizing it. My biggest weakness is a lack of long-term planning ability. I often feel overwhelmed and I do not know where to start. It is as if I decided to clean my room, and so dumped everything out on the bed, and then just stand there because I am not sure what I should do to begin. I often found myself procrastinating, not out of laziness, but out of a general intimidation towards the work and what needed to get done. However, I have realized that if I struggle with a particular task, I will grasp it and know how to solve it. What I have learned to overcome is that intimidation.

In the future, I will improve myself by taking projects head-on. During this project, I looked for other work to do in the meantime to delay the inevitable, which has included everything from other homework to thoroughly cleaning the house. I have learned to set aside some time to figure out complex problems, and after I did that, it was never as bad as I had imagined it. This insight will allow me to grow professionally, and set larger, more ambitious long-term goals for my students and myself. It will help me personally as I will be able to make longer-term plans for how I want to grow throughout life. My strength as a teacher is my enthusiasm. I am an energetic person that could never sit behind a desk. If I couple that strength with my newfound solution to my weakness, I think I'll improve drastically as a professional. In fact, that is one of the most important things I have learned throughout my entire experience as an MSSE student.

As a teacher, I will continue to put my efforts into making engaging and stimulating lessons for my students. It is obvious that these lessons benefit both my students and me. I am going to start implementing this type of intervention as often as possible. In the future, I would like to study the difference between group activities and individual activities and the effects they have on students' motivation. That research, coupled with what I have learned here, would allow me to better serve my students and myself.

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APPENDICES

APPENDIX A

NONTREATMENT PREUNIT SCIENCE ASSESSMENT

NONTREATMENT UNIT PREUNIT SCIENCE ASSESMENT

1. Name two features of amphibians.

___

2. Name two features of reptiles.

___

3. How are fish different from mammals?

___

4. There is a new animal that has gills, fins, and scales. What kind of animal is it?

___

5. You have a reptile that is born on land, has scaly skin and cold blood. If you were able to change it into a fish, what would you have to change about it?

___

6. Humans are mammals, and as you know, we sometimes live in very cold places. Why are we able to do this?

___

APPENDIX B

NONTREATMENT ENGLISH ASSESSMENT

NONTREATMENT UNIT ENGLISH ASSESSMENT

The following words were read to the class. The students had to write them down on a separate sheet of paper and spell them correctly to get full credit.

1. animal
2. backbone
3. mammal
4. bird
5. fish
6. reptile
7. amphibian
8. arthropod
9. scales
10. skeleton

APPENDIX C

PRETINTERVENTION STUDENT INTERVIEW QUESTIONS

PREINTERVENTION STUDENT INTERVIEW QUESTIONS

Please know that you don't have to do this interview. If you ever want to stop answering questions, just tell me.

1) Do you understand this aspect of science?
    a.
    b. Explain the rating:
2) What was your favorite thing?
    a.
    b. Why?
3) Will you remember a little or a lot of today's class?
    a.
4) Are you excited to learn about science?
    a.
    b. Explain the rating:
5) What did you not like?
    a.
    b. Why?
6) How much do you like science?
    a.
    b. Explain the rating:
7) What excited you the most? Why?
    a.
8) What made you want to learn more?
    a.
9) Are there any questions you think I should have asked, but didn't?
    a.

Is there anything else you want to tell me?

APPENDIX D

PRE AND POSTINTERVENTION STUDENT ATTITUDE SURVEY

STUDENT ATTITUDE SURVEY

Date: _____/______/___________

DON'T PUT YOUR NAME ON THIS!

Please know that you don't have to do this survey. If you ever want to stop answering questions, just tell me.

Questions	*Ratings*
How much do you like science?	
How much did you like this aspect of science?	
How much do you want to learn more?	
How well do you understand this aspect of science?	
Will you remember this aspect of science for a while?	

What do you like best about this aspect of science?

____

____

What do you want to do more of?

____

____

Are there any other questions I should have asked? Would you like to add anything else?

____

____

APPENDIX E

NONTREATMENT UNIT STUDENT WORKSHEET

NONTREATMENT UNIT STUDENT WORKSHEET

What is an animal? ____

____

Not all animals are the same, but some are similar to others. Animals that are similar to other animals can be grouped into classes. The first difference between animals is the backbone. Some animals have one and others don't.

Animals WITH Backbones	
Mammals	• Have hair on their bodies • Drink milk as babies • Examples: HUMANS, dogs, whales, kangaroos, horses
Birds	• Have feathers • Born from hard-shelled eggs • Examples: peacocks, crows, robins, blue jays, penguins
Fish	• Live in water • Have gills, fins, and scales • Examples: salmon, swordfish, trout, goldfish, clown fish
Reptiles	• They have scaly skin • Cold-blooded and born on land • Examples: snakes, lizards, crocodiles, turtles, alligators
Amphibians	• Born in the water and have gills as babies • Grow lungs as adults • Examples: frogs, toads, salamanders
Animals WITHOUT Backbones	
Arthropods	• They have more than four jointed legs • Their skeleton is on the outside • Examples: spiders, ants, butterflies, crickets

APPENDIX F

NONTREATMENT UNIT SAMPLE LESSON PLAN

NONTREATMENT UNIT LESSON PLAN

Section	**Description of Activity**
Introduction to Science	I introduced the concept of *science*. I asked the students, “What is science?” I then explained to them that *science* is a way of asking questions and finding answers to problems in our universe, and that we can ask questions about many different things.
Introduction to Animals	I introduced the students to what animals were. I asked them questions like, What animals do you know? How are plants and animals different? I explained to them that there are many differences, but that animals can move freely and that they must eat food to survive (i.e. they can’t make it via photosynthesis like plants can).
Introduction to Backbones	I reminded the kids what bones were. Then I asked them if they could guess what a *backbone* was? Some students correctly guessed. Then I asked them if all animals had backbones. Some said yes, and I had to remind them that not all animals had backbones (e.g. worms, spiders, ants).
Introduction to Mammals and Birds	I then introduced my students to mammals and birds. I explained that all mammals drink milk as babies and have hair. I also explained that all birds are born from hard-shelled eggs and they all have feathers. I also explained that *both* birds and mammals have backbones; however, their other characteristics that I taught them were mutually exclusive.
Review	We then reviewed the differences between animals and other organisms. We also reviewed what a backbone was and how some animals have backbones and other don’t. We ended with a review of the spelling of certain keywords, such as mammal, bird, animal, and backbone.

APPENDIX G

NONTREATMENT POSTUNIT AND DELAYED SCIENCE ASSESSMENT

NONTREATMENT UNIT POSTUNIT AND DELAYED SCIENCE ASSESSMENT

1. Name two features of mammals.

2. Name two features of fish.

3. How are amphibians different from reptiles?

4. There is a new animal that has scales, is born on land, and is cold blooded. What kind of animal is it?

5. You have a fish with gills, fins, and scales that lives in the water. What do you have to do to it to make it a mammal?

6. Do you think you're going to find more insects in a cold area or a warm area? Why?

APPENDIX H

POSTTREATMENT AND DELAYED STUDENT INTERVIEW QUESTIONS

POSTTREATMENT AND DELAYED STUDENT INTERVIEW QUESTIONS

Please know that you don't have to do this interview. If you ever want to stop answering questions, just tell me.

1) How well do you understand this aspect of science?
    a.
    b. Explain the rating:
2) What was the easiest thing to learn?
    a.
3) What will you remember tomorrow? Why will you remember it?
    a.
4) How excited are you about learning this aspect of science?
    a.
    b. Explain the rating:
5) What's you favorite thing about class? What's your least favorite thing?
    a.
6) Do you remember all of the science we've learned lately? What do you remember the best?
    a.
7) Do you learn more with the hands-on activities than without them?
    a.
8) How much do you like science?
    a.
    b. Explain the rating:
9) Are there any other questions that you think I should have asked?
10) Is there anything else you want to tell me?

APPENDIX I

FIRST TREATMENT UNIT PREUNIT SCIENCE ASSESSMENT

FIRST TREATMENT UNIT PREUNIT SCIENCE ASSESSMENT

1. What is Mars?

___

2. What is the largest planet in our solar system?

___

3. Compare the size of asteroids and planets.

___

4. You learn that a solar body is very large, made up of burning gas, and has rocks that orbit around it. What do you think it is?

___

5. There is a small ball of ice and dust flying through space in orbit around the sun. What would you have to do to it to make it a planet?

___

6. All of the inner planets are made of rock, while all of the outer planets are made or gas? Why?

___

APPENDIX J

FIRST TREATMENT UNIT ENGLISH ASSESSMENT

FIRST TREATMENT UNIT ENGLISH ASSESSMENT

The following words were read to the class. The students had to write them down on a separate sheet of paper and spell them correctly to get full credit.

1. star
2. planet
3. comet
4. asteroid
5. sun
6. Mercury
7. Earth
8. Jupiter
9. Saturn
10. Neptune

APPENDIX K

FIRST TREATMENT UNIT SAMPLE LESSON PLAN

FIRST TREATMENT UNIT LESSON PLAN

Section	**Description of Activity**
Introduction to the Solar System	I introduced the concept of outer space and the solar system. The kids already knew what it was from their Chinese school. I introduced them to the concepts to stars and planets, and explained that our sun is a star. I also explained the differences between solids and gases, and that the outer planets were made up of gasses and the inner planets were not (except for their atmospheres, where existent).
Introduction to Gravity and Orbits	I showed my students what gravity was and told them that this is how and why things, such as planets and moons, orbit around each other. I demonstrated this orbiting motion with a workable 3D model my school had where I could rotate planets around the sun.
Current Events: Space Exploration	I told my students that we, humans, have walked on the moon before. I showed them the video of Neil Armstrong taking his first steps on the moon. Then, I brought them into more current times by showing them the International Space Station, the Cassini-Huygens spaceship, and the Mars Rover.
Hands-On Activity: Building a Solar System Model	I had the kids separate into groups or three or four and together build a model of the solar system using painted foam balls that I had put together before the class. They used sticks of varying length to simulate the approximate distance between the planets and the sun.
Review	I then reviewed essential vocabulary that we learned, such as: planet, orbit, star, the Sun, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

APPENDIX L

FIRST TREATMENT UNIT STUDENT WORKSHEET

FIRST TREATMENT UNIT STUDENT WORKSHEET

There are many different things in our solar system. There are planets, a star, asteroids, and comets. Some of these things are big and some are small. Some are hot and some are cold. Today, we're going to learn about them.

Objects in the Solar System	
Stars	• HUGE ball of burning gas • VERY hot • VERY bright • Example: the Sun
Planets	• ORBIT a star • They can be made of gas or rock, or sometimes both • Examples: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
Comets	• Made of rock, dust, water, and ice • Orbit the sun in a very large orbit • Can create a "tail"
Asteroids	• Rocks that orbit the sun • Very small in size • More similar to comets than planets

APPENDIX M

FIRST TREATMENT UNIT POSTUNIT AND DELAYED SCIENCE ASSESSMENT

FIRST TREATMENT UNIT POSTUNIT AND DELAYED SCIENCE ASSESSMENT

1. What is Saturn?

2. What is the smallest planet in our solar system?

3. Compare the size of the planets and the Sun.

4. You learn that a solar body is very small, made up of rock, and orbits the Sun in about 2 ½ Earth years. What do you think it is?

5. There is a large burning ball of gas in the sky. What would you have to do to it to make it a planet?

6. Do planets with larger orbits travel around the Sun faster or slower than planets with smaller orbits, or is it not related at all? Why?

APPENDIX N

SECOND TREATMENT UNIT PREUNIT SCIENCE ASSESSMENT

SECOND TREATMENT UNIT PREUNIT SCIENCE ASSESSMENT

1. _______________ is when the air cools and the water vapor becomes water again, creating clouds.

2. After cooling, water vapor becomes liquid water again. This process is called:

3. What are two reasons for how evaporation differs from the other stages of the water cycle?

4. If you see a pot of liquid water and you want it to evaporate quickly, what should you do?

5. If it's raining, is the weather likely to be hotter or colder than it normally is, or will it be the same? Why do you think this?

6. People think of hot sand deserts as being the driest places on Earth. Actually, ice land deserts are the driest places on Earth. Why?

APPENDIX O

SECOND TREATMENT UNIT ENGLISH ASSESSMENT

SECOND TREATMENT UNIT ENGLISH ASSESSMENT

The following words were read to the class. The students had to write them down on a separate sheet of paper and spell them correctly to get full credit.

1. evaporation
2. condensation
3. precipitation
4. collection
5. vapor
6. rain
7. cloud
8. runoff
9. atmosphere
10. cycle

APPENDIX P

SECOND TREATMENT UNIT STUDENT WORKSHEET

SECOND TREATMENT UNIT STUDENT WORKSHEET

Look at the glass of water on your desk. Where did that water come from? Yes, I know it came from the sink … before that! How long has it been here? The truth is, that water has been here for a VERY long time. It has been here longer than you or I. It just gets RECYCLED from one area to another. That's what we're going to learn about today.

STAGES OF THE WATER CYCLE	
Evaporation	• The sun heats up water • The water turns to vapor • The vapor goes into the air
Condensation	• The vapor cools down in the air • Then it condenses • It forms clouds
Precipitation	• All of the condensed water becomes too heavy for the air to hold it • So, it falls to the Earth as water • This is how rain and snow happen
Collection	• When it hits the Earth, the water can do different things • It can go into the ground where plants will drink it • It can roll on the Earth and collect in lakes, rivers, and oceans

APPENDIX Q

SECOND TREATMENT UNIT POSTUNIT AND DELAYED SCIENCE ASSESSMENT

SECOND TREATMENT UNIT POSTUNIT AND DELAYED SCIENCE ASSESSMENT

1. _______________ is when the air cannot hold any more water, so it falls to the Earth.

____

2. After cooling, water vapor becomes liquid water again. This process is called:

____

3. What are two reasons for how evaporation differs from the other stages of the water cycle?

____

4. If you see a pot of liquid water and you want it to evaporate quickly, what should you do?

____

5. If it's raining, is the weather likely to be hotter or colder than it normally is, or will it be the same? Why do you think this?

____

6. People think of hot sand deserts as being the driest places on Earth. Actually, ice land deserts are the driest places on Earth. Why?

____

APPENDIX R

TEACHER FIELD OBSERVATION PROMPTS

TEACHER FIELD OBSERVATIONS

As I proceeded with my research, I conducted field observations of individual students. I used the following table to collect my data:

Student's Code	Achievement Group	Observations and Notes

In addition, the following prompts were used:

1. How enthused do the students seem today on a scale of 1-5? Why do you think that?

2. How motivated are the students to finish the assignments and continue learning more? Why do you think that?

3. Do any students not seem enthused? If so, how many are there and why do they seem despondent?

4. Do you have any ideas on how to augment your students' enthusiasm? Why do you think these ideas will be constructive?

5. How did students respond to the formative assessments that were employed during the class?

6. Are there any other questions that you think should have been asked?

7. Is there anything else that's on your mind?

APPENDIX S

TEACHER ATTITUDE SURVEY

TEACHER ATTITUDE SURVEY

Mark your answers on a Likert scale of 1-5, 5 being either the most comfortable, or the most enthusiastic, depending on the question.

Questions	*Ratings*				
After today's lesson, how enthused are you about continuing to deliver the unit in this manner?	1	2	3	4	5
Why?					
After today's lesson, how do you feel about your energy to continue at the same pace?	1	2	3	4	5
Why?					
After today's lesson, how interested are you in continuing to develop lesson plans in the same format as today's lesson?	1	2	3	4	5
Why?					
After today's lesson, how well do you feel your students learned what you taught them?	1	2	3	4	5
Why?					
After today's lesson, how motivated are you to continue doing action research in the future?	1	2	3	4	5
Why?					

Are there any questions not listed on here that you think would be appropriate to ask in light of today's lesson?

____

____

Do you have any other comments?

APPENDIX T

TEACHING JOURNAL PROMPTS

TEACHING JOURNAL PROMPTS

1. Explain how successful do you feel today's lesson was.
    a. Why do you feel this way?
2. Describe any outstanding student achievements or moments of enlightenment.
3. Looking back on today's lesson, what excited you most?
    a. Why did this excite you?
4. What are you looking forward to in the future?
    a. Why are you looking forward to it?
5. What do you think you could have done better after thinking about today's lesson in hindsight?
    a. What changes do you think such alterations would have had on the outcome?
6. Is there anything else that you want to add about today's lesson?

APPENDIX U

COLLEAGUE OBSERVATION PROMPTS

COLLEAGUE OBSERVATION PROMPTS

1. How enthused do the students seem today on a scale of 1-5? Why do you think that?

2. How motivated are the students to finish the assignments and continue learning more? Why do you think that?

3. Do any students not seem enthused? If so, how many are there and why do they seem despondent?

4. Do you have any ideas on how to augment the students' enthusiasm? Why do you think these ideas will be constructive?

5. How did students respond to the formative assessments that were employed during the class?

6. How motivated does the teacher seem during this lesson?

7. What seems to be affecting the teacher's motivation and enthusiasm.

6. Are there any other questions that you think should have been asked?

7. Is there anything else that's on your mind?

APPENDIX V

IRB FORM

Dear Candy or Hugo:

I am currently working towards completing a Masters of Science in Science Education at Montana State University in the United States. To complete my degree, I am conducting research about how hands-on activities affect students' understanding of scientific concepts and their motivation towards the sciences. I would be very grateful if you would allow me to conduct my research project at your school.

I intend to use student assessments, interviews, surveys, and observations to collect data for my project. I have focused my project on understanding the effects of formative assessments with targeted, real world, current events, and hands-on activities on students' understanding of elementary-level scientific concepts. I promise that I will conduct my research ethically. The student's information will be kept confidential. In addition, I will be studying my own attitudes as they relate to teaching in hopes of bettering myself as a teacher.

If you agree to allow me to conduct my research, please sign this form.

Sincerely,

Christopher Rocheleau
Hugokids Language School
ccrocheleau@gmail.com
09-7856657

I, Candy/Hugo, owner of Hugokids Language School, give permission for Christopher Rocheleau to conduct his research in his classroom at Hugokids Language School.

Candy Hung
Owner's Signature

Nov. 6th, 2012
Date

!

APPENDIX W

PROJECT TIMELINE

PROJECT TIMELINE

March 1 - Nontreatment preunit Assessment.
Started nontreatment preunit concept interviews.
March 4 – Direct instruction: Classification of Animals
March 7 – Continued instruction: Classification of Animals
March 8 – Continued instruction: Classification of Animals
March 11 – Continued instruction: Classification of Animals
March 14 – Nontreatment postunit student assessments, surveys and interviews.

March 15 – First Treatment Unit 1 preunit assessments, surveys and interviews.
March 18 – Direct instruction: The Solar System
March 21 – Intervention with hands-on activities and current events
March 22 – Intervention with hands-on activities and current events
March 25 – Intervention with hands-on activities and current events
March 28 – First Treatment Unit 1 postunit student assessments, surveys and interviews.

March 29 – Second Treatment Unit 2 preunit assessments, surveys and interviews.
April 1 – Delayed nontreatment unit assessments
April 4 – Direct instruction: The Water Cycle
April 5 – Intervention with hands-on activities and current events
April 8 – Intervention with hands-on activities and current events
April 11 – Intervention with hands-on activities and current events
April 12 – Second Treatment Unit 2 postunit assessments, surveys and interviews.
April 19 – Delayed unit 1 assessments
May 3 – Delayed unit 2 assessments