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University of Nevada, Reno

The Effectiveness of the Blended/Tiered Vocabulary Approach in English Only Compared to English with Spanish Supports

A thesis submitted in partial fulfillment
of the requirements for the degrees of

Bachelor of Arts in Spanish, Bachelor of Sciences in Education, and the Honors Program

by

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December, 2014

**UNIVERSITY
OF NEVADA
RENO**

THE HONORS PROGRAM

We recommend that the thesis
prepared under our supervision by

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entitled

**The Effectiveness of the Blended/Tiered Vocabulary Approach in English Only Compared
to English with Spanish Supports**

be accepted in partial fulfillment of the
requirements for the degrees of

BACHELOR OF ARTS, SPANISH and BACHELOR OF SCIENCE, EDUCATION

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December, 2014

Abstract

The Blended/Tiered approach to vocabulary instruction is a mix of previously successful teaching methods used in classrooms, including tiered vocabulary and inquiry instruction. This approach has been shown to be effective in teaching academic vocabulary, even with English Language Learners; however, the approach has only once been used with instruction in multiple languages. This study aims to find out if there was a difference in material learned and retained by English Language Learners and native English speakers when Spanish was used with the Blended/Tiered approach to vocabulary instruction. Two-third grade classes were exposed to six inquiry-based lessons involving the Blended/Tiered approach to vocabulary instruction. Spanish supports were used in the lessons in one class, while the lessons implemented in the other class were strictly English. Students took one test three times, as a pretest, posttest, and post-posttest, in order to measure learning and retention over time. The results supported the use of the Blended/Tiered approach in the classroom and suggested that Spanish supports may provide an added benefit related to retention of learned material as well as amount of time material is retained.

Acknowledgement

I would like to thank the teachers and the students of the classes where I was able to do my research. The students were always excited and ready to participate in the lessons. I also wish to thank the parents of the students for allowing them to participate in the lessons, as these students were the key part of this research. In addition, thank you to the principal of the school and the school district for allowing me to work in these two classrooms.

My next thank you goes to my mentor, Dr. David Crowther. Without his ideas, help, and guidance, this research would never have been possible.

Finally, I would like to thank the Office of Undergraduate Research at the University of Nevada, Reno. Through this office, I was awarded the Honors Undergraduate Research Award, which allowed me to purchase necessary supplies for the lessons that were taught.

Table of Contents

| | |
|-----------------------------------------------------------------------------|-----|
| Abstract | i |
| Acknowledgement | ii |
| Table of Contents | iii |
| List of Tables | v |
| List of Figures | vi |
| Chapter 1 – Introduction | 1 |
| Overview | 1 |
| Purpose of Study | 5 |
| Research Question | 6 |
| Theoretical Perspective | 6 |
| Definition of Terms | 8 |
| Chapter 2 - Review of the Literature | 10 |
| The Warm-Up: Philosophy, Instruction, and Methods | 10 |
| The Players: English Language Learners | 14 |
| Practicing for the Game: Spanish in the Classroom | 19 |
| Plan of Attack: The Blended/Tiered Approach to Vocabulary Instruction | 24 |
| Chapter 3 – Methods | 26 |
| Research Design | 26 |
| Subjects | 29 |
| Instruments and Materials | 30 |
| Data Collection Procedure | 31 |
| Data Analysis | 32 |

| | |
|-----------------------------------------------------------------------------------|-----|
| Chapter 4 – Results | 34 |
| Chapter 5 – Discussion | 39 |
| Conclusion | 39 |
| Group Means and Standard Deviations | 39 |
| Tukey Kramer Multiple Comparisons Tests and Effect Size Analyses | 41 |
| Discussion | 44 |
| Questions for Future Research | 49 |
| Chapter 6 – References | 50 |
| Appendix A: Lesson Plan 1: Introduction to Weather and Atmospheric Pressure | 54 |
| Appendix B: Lesson Plan 2: Temperature | 63 |
| Appendix C: Lesson Plan 3: Wind Direction | 70 |
| Appendix D: Lesson Plan 4: Clouds, Precipitation, Humidity | 78 |
| Appendix E: Lesson Plan 5: Climate Versus Weather (Engineering Too) | 87 |
| Appendix F: Unit Assessment | 101 |
| Appendix G: Unit Assessment Key | 104 |

List of Tables

| | |
|-------------------------------------------------------------------------------|----|
| Table 1. Group Means and Standard Deviations of Raw Scores | 34 |
| Table 2. Analysis of Variance of Raw Scores | 35 |
| Table 3. Turkey Kramer Multiple Comparisons Test with Raw Scores | 35 |
| Table 4. Effect Sizes of Selected Raw Scores | 36 |
| Table 5. Pooled Effect Size of Raw Post-Posttest Score | 36 |
| Table 6. Group Means and Standard Deviations of Value-Added Scores | 37 |
| Table 7. Analysis of Variance of Value-Added Scores | 37 |
| Table 8. Turkey Kramer Multiple Comparisons Test with Value-Added Scores..... | 37 |
| Table 9. Pooled Effect Size of Value-Added Post-Posttest Score | 38 |

List of Figures

| | |
|----------------------------------------------------------------------------------------------------------|----|
| Figure 1. Graphical Representation of the Blended/Tiered Approach to Vocabulary Instruction..... | 4 |
| Figure 2. Next Generation Science Standards, 3-ESS2 Earth’s Systems | 26 |
| Figure 3. Graphical Representation of Group Means and Standard Deviations of Raw Scores . | 40 |
| Figure 4. Graphical Representation of Group Means and Standard Deviations of Value-Added Scores | 41 |

Chapter 1

Introduction

Overview

According to the 2011 United States Census Bureau, the total number of people over the age of five in the United States who spoke a language (any language) was 291,524,091 people. About 1/8 of this population spoke Spanish or Spanish Creole, or 12.9% of the total U.S. population. Of the 12.9%, about 43.7% spoke English “less than very well.” The next highest category of speakers was Chinese, with 0.1% (Ryan, 2013). Within schools in a particular western state of the United States of America, there were a total of 445,381 students enrolled in the state’s public schools in the 2012-2013 school year. Of these, 14.9% of the students were considered to have Limited English Proficiency. Looking at a specific district within the western state, about 16.4% of the students were considered to have Limited English Proficiency during the 2012-2013 school year. ("Demographic profile: Year," 2013).

Due to factors like learning style, language(s) spoken, and diversified learners, classrooms have grown into varied learning environments, trying to incorporate all types of learning for all students, while still making sure to “implement” the school curriculum effectively (Reyes, 2008, 96). In many cases, struggling students and diverse learners have been reached through different instructional methods and strategies. One instructional method used to accommodate all learners is inquiry learning. Inquiry learning is a method of instruction (Bybee, 2002). Inquiry learning differs from the more traditional direct instruction, in that instruction is more student paced and a combination of student and teacher led. The more traditional method of instruction is direct instruction. In direct instruction, the teacher is in charge of all learning and does the majority of the talking during the lesson, *telling* the students the content (Koziuff,

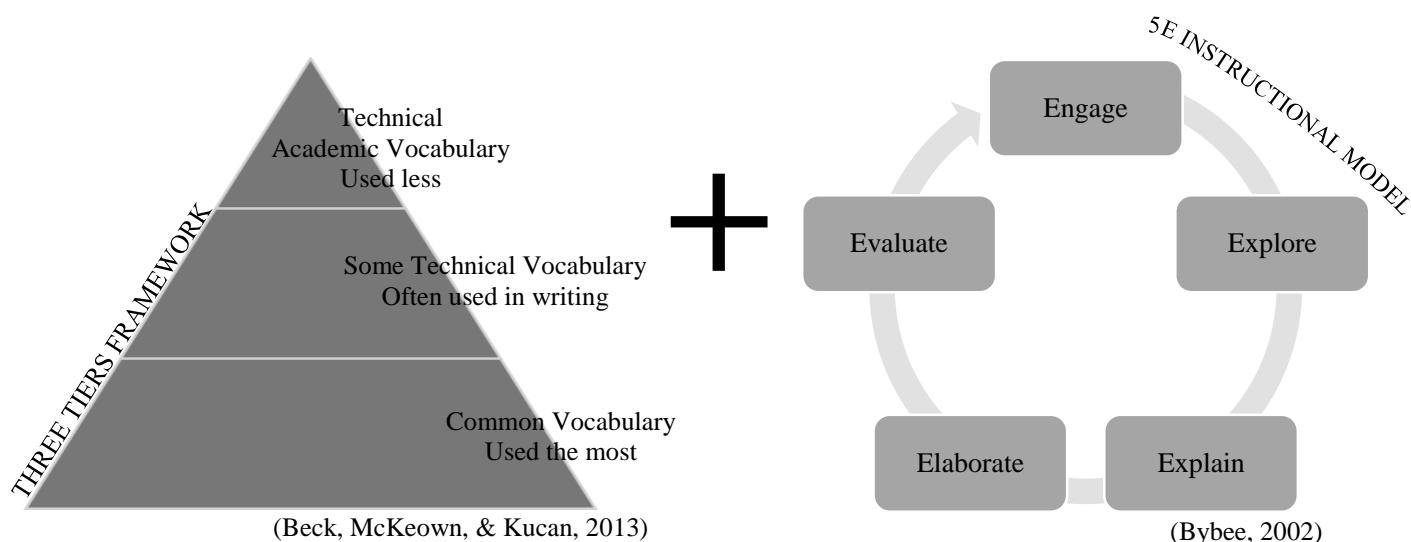
LaNunziata, Cowardin, & Bessellieu, 2001). While the teacher's role is center stage in direct instruction, the role is more of a backstage director in inquiry instruction. The teacher plans the lesson, arranging the lesson so students can discover the concepts to be learned on their own. While some of the discovered concepts may be unplanned, in general, the teacher leads the students to the concepts through the lesson, yet the actual discoveries are student based. The teacher provides support and gives some information after the initial discoveries, but the students are always active participants in the lessons, instead of bored audience members viewing the teacher's solo act (Bergman, 2013).

Rodger Bybee promoted the concept of inquiry learning with his 5E Instructional Model, a model of the inquiry instruction method. He based his model on the idea that, "the natural inquiry of children and the more formal problem solving of adults often follow a pattern of initial engagement, exploration of alternative, formation of an explanation, use of the explanation, and evaluation of the explanation based on its efficacy and responses from others" (2002, 31). The natural learning that small children do to explore their world is not the same as the learning of a school environment; yet there is a correlation between natural curiosity and the more structured inquiry that can be used to learn in school. The inquiry model proposed by Bybee is titled the BSCS 5E Instructional Model. The cycle consists of five phases that build upon the previous phases in order to make learning accessible for all students. The BSCS 5E Instructional Model is an instructional model that has been shown to be effective with diverse learners (Dong, 2013, 52).

Isabel Beck, Margaret McKeown, and Linda Kucan present a teaching strategy titled the "Three Tiers Framework," which has been specifically used to address vocabulary instruction for all learners, including diverse learners (2013, 9). The Three Tiers Framework breaks a mature

human's vocabulary down into three different levels (tiers) of words. Tier one is the most basic level; these are words students use on a daily basis, which appear in normal conversation, for instance "warm...talk...and look" (9). Since they appear in normal conversation, students have many opportunities to learn these tier one words and consequently, these words do not need a lot of instructional attention at school. Tier two words sometimes appear in conversation, but are more often used in writing. Therefore, they are still not true "technical" terms, but they are words that students are less exposed to on a daily basis and may require some teaching, for instance "circumstances" (9). Tier three words are technical vocabulary words that are highly specific to certain fields and are learned within those fields, for instance, "filibuster, pantheon, and epidermis" (9). Beck, McKeown, and Kucan present the framework as a way for teachers to decide which vocabulary words to teach and focus on with their students.

The Blended/Tiered Approach to Vocabulary Instruction combines the 5E Instructional Model and the Three Tiers Framework, as seen in Figure 1. The approach is a strategy that scaffolds the tiered words at opportune times during the 5E Instructional Model in order to "discover the content through an experience that can then be labeled by new tier three vocabulary" (Crowther, 2013, 13). Instead of forcing students to memorize vocabulary words that have no meaning for them, new words are related to previously known words and associated with the current activities in order to create shared experiences connected to the new vocabulary.



The Blended/Tiered Approach to Vocabulary Instruction

Figure 1. Graphical Representation of the Blended/Tiered Approach to Vocabulary Instruction.

This figure shows the combination of the Three Tiers Framework and the 5E Instructional Model.

As the Blended/Tiered approach is relatively new and has not been used with Spanish supports before, this study aimed to add to the knowledge base of the approach, and implemented the approach with Spanish supports in a classroom containing over 50% English Language Learners. Two third-grade classrooms in a western state participated in six hands-on, 5E Instructional Model lessons that included tiered vocabulary. The experimental group received these lessons with Spanish supports as well as the English content. In order to measure efficiency, students were given a pretest and a posttest that gave students the option to use English and/or Spanish. In addition, a post-posttest looked at retention of content over time in order to see if the addition of Spanish supports improved retention of the material. All tests used the same assessment instrument.

Students have prior knowledge and experiences. Learning becomes more effective when

students can relate the new information to prior information. For many students, the prior knowledge and these experiences may have occurred in a language other than English or more often in a combination of languages. The lessons used in this study aimed to connect the two, hopefully connecting the new information to students' prior knowledge (in any language), and therefore making the lessons more applicable to the students. For English speakers, the Spanish supports may have provided just enough extra information that the word in one language or both became more familiar and usable, as was seen in the study by Ramos (2005). Ramos shows that when bilingual teachers were brought in from Spain to help Californian English Language Learners, the teachers started to use Spanish in order to help the English Language Learners. The native English speakers noticed the use of Spanish and introduced a discussion about the use of Spanish in the classroom and the progress that the English Language Learners were making, which ended up opening up a discussion about Spain and Spanish, adding to the native English speakers' knowledge about these topics.

Purpose of Study

The purpose of this study was to look at the effectiveness of two successful teaching strategies: Tiered Vocabulary and the 5E Instructional Model, when combined as the Blended/Tiered Approach to Vocabulary Instruction and when used in a classroom with a high percentage of English Language Learners. The Blended/Tiered Approach to Vocabulary Instruction is still in the introductory stages, but has been shown to be effective in mainstream classes in a study by Crowther (2013) and a two-way-immersion class in a study by White and Crowther (2013). The research by Crowther summarized five separate studies using the Blended/Tiered approach in mainstream classrooms (with some English Language Learners) and contributed to the research on the effectiveness of the approach through varying effect sizes

between the given pretests and posttests. The varying studies demonstrated a high retention of vocabulary over time, based on post-posttest scores (Crowther, 2013). In the two-way-immersion setting where the Blended/Tiered Vocabulary Approach was used, students showed statistically significant point gains between the pretest and the posttest. They continued to show point gains from the posttest to the post-posttest as well (White & Crowther, 2013). As of 2014, the Blended/Tiered approach has been used with mainstream students, with English Language Learners, and in a two-way-immersion setting, but the *one* study in a two-way-immersion class is the only time that the Blended/Tiered approach has been used in a language other than English (White & Crowther, 2013).

Research Question

Do English Language Learners and native English speakers learn and/or retain more content information from lessons that use the Blended/Tiered Approach to Vocabulary Instruction in English and in Spanish compared to students who are exposed only to the Blended/Tiered Approach to Vocabulary Instruction in English?

Theoretical Perspective

In order to understand the theoretical perspective upon which this study is based, some Second Language Acquisition (SLA) theory must be understood. While there are different thoughts on SLA, the theory followed in this research, the Sociocultural Theory, was originally proposed (under a different title) by Vygotsky in 1978. Sociocultural Theory proposes that the second language is not only learned through a process of the mind, but also learned through external factors as well. External factors may include artifacts, tasks, or other environmental elements, but *especially* external social influences, “An interpersonal process is transformed into an intrapersonal one. Every function in the child’s cultural development appears twice: first, on

the social level, and later, on the individual level; first, *between* people (*interpsychological*), and then *inside* the child (*intrapsychological*)” (Vygotsky, 1978, 57). Sociocultural Theory proposes that memorizing 30,000 German verbs in a room alone will not help a learner speak German better than if he or she immerses himself or herself in the language. “Language is *not learned in isolation*. Language is acquired through social interaction and conversation” (Curtin, 2009, 32). Sociocultural theory says that second language acquisition is based on the idea that the language needs to be used for a reason (32).

Following this view of second language acquisition, an experiential approach should be used by teachers to teach the second language; students should be *experiencing* the language in order to learn (Lee, Quinn, & Valdés, 2013, 228). This study is also based on assumptions from the Constructivist Learning Theory, where students use their prior knowledge to create a context for new knowledge. In the case of science instruction, students should use hands-on science where they are able to experience the concepts they are learning (Orgill & Thomas, 2007).

Systemic Functional Linguistics Perspective was also followed in this study. Originally presented by Halliday, Systemic Functional Linguistics states that language is “a *resource for meaning* rather than a system of rules. It is oriented, in other words, to speakers’ meaning potential (what they can mean)” (Halliday & Martin, 1993, 22). Halliday and Martin theorize that language and function develop alongside each other, meaning new language is developed to talk about new events. Language is a tool for “meaning-making” in the different disciplines, including science (23). Therefore, while many consider the vocabulary of science a separate vocabulary from the common vocabulary, Halliday and Martin see the language of science as an additional tool to present the scientific concepts, but that the scientific language can still be related to more common vocabulary (1993).

As seen in the tiered vocabulary framework presented by Beck, McKeown, and Kucan (2013), the specialized vocabulary of disciplines can be highly technical and different from the social vocabulary. However, technical vocabulary can also have social vocabulary words that are relatable (2013, 226). A student may have the words “rain” or “water” in his or her social vocabulary, but may be missing “precipitation.” With the help of peers or the teacher, the words rain and water can be compared and scaffolded to understand precipitation, and the technical word then becomes more accessible. English Language Learners are therefore able to use their peer and teacher connections (Sociocultural Theory) to build on their prior knowledge (Constructivist Theory) in order to have the functional tools (Systemic Functional Linguistics Perspective) to reach the previously unattainable language needed to learn science content.

Definition of Terms

5E Instructional Model: Teaching method that uses inquiry instruction to make the learning in school more like the natural learning of children. Uses a learning cycle consisting of five phases, the Engagement, Exploration, Explanation, Elaboration, and Evaluation (Bybee, 2002, 32).

BICs: Basic Interpersonal Communication skills are the vocabulary used in the home and amongst friends and family, also known as social vocabulary or the informal register (Curtin, 2009, 31).

CALP: Cognitive Academic Language Proficiency, also known as Academic Vocabulary or the formal register, is the content specific (tier three) words that students need to know in order to be successful in school and professional settings (Curtin, 2009, 31).

Inquiry: From an educational standpoint, a method of instruction (often used in science)

that simulates the natural curiosity of a child looking for answers. Teachers act as facilitators to help students discover the answers instead of directly telling the students information (Bybee, 2002).

Chapter 2

Review of the Literature

The Warm-Up: Philosophy, Instruction, and Methods

Teachers teach in many different ways. The two main modes of instruction used in schools currently are direct instruction and inquiry instruction. Both are based on philosophies of education and the different theories on how students learn. Emerging from the behaviorist approach to education is direct instruction. The behaviorist philosophy of education is based on the ideas that teachers should implement research based methods in their teaching, which should be guided by the responses (behaviors) of the students. Direct instruction has been used within many disciplines, including science, math, literacy, and history. In the direct instruction teaching model, all learning depends on the teacher. “If the students aren’t learning, the teacher isn’t teaching” (Koziuff, LaNunziata, Cowardin, & Bessellieu, 2001). Low achievement is not the result of any student factors, but instead, could be insufficient training or planning on the part of the teacher, or the curriculum is not appropriate. Direct instruction has been shown to be effective in teaching “basic reading and math skills” to English Language Learners, minority learners, and other “disadvantaged” groups (Koziuff, LaNunziata, Cowardin, & Bessellieu, 2001). The teacher is in charge of the whole lesson, which is planned out and scripted; therefore, the teacher is ready to lead students to the necessary concepts. As lessons in a particular content area progress, the students should gain more and more knowledge until they are more able to work independently, thus modeling their own behavior after the behavior of the teacher.

One of the other main instructional methods currently used in schools in the United States is inquiry based instruction. While direct instruction branches out from behaviorist thoughts, inquiry based instruction grows from constructivism. Rita W. Peterson touches on this concept

when discussing inquiry. “Children appear to construct and reconstruct their ideas about natural events or phenomena after verifying first-hand that their previous conceptions no longer hold the same explanatory power” (2002, 18). As children add new knowledge to their old understandings, they often have to reevaluate old thoughts and update their ideas. Yet for a long time, science instruction did not account for this type of learning. Instead, mistakes were not made, or if there were mistakes, they were not published. As the years went on, the ideas about science as a discipline changed, making science more of a process of science instead of a discrete idea. Scientists started inquiring and asking questions in order to discover new concepts. Since scientists did not know the answers and outcomes, “stalemates, doubts, and failures” were possible (Schwab & Brandwein, 1962, 21). Yet the new *process* of science did not move into the elementary classroom right away. In the “teaching laboratories,” science was still a concrete set of steps that pressed for perfection, “accuracy, and precision” (39). In other words, there were always predictable outcomes with no failures or problems.

Eventually, the new way of looking at science as a process moved into the elementary classroom, and a teaching model came along with it. Humans have an “innate curiosity” that makes them want to explore their world (Thier, 2002, 34). By investigating scientifically, students draw conclusions “based on factual evidence, not hearsay or opinion” (34). Students are then able to “develop effective techniques for testing and observing everything around them, they learn the what, how, when, and why of things with which they interact and become *scientifically literate*” (34). In order to simulate this *innate curiosity*, inquiry instruction developed. In direct instruction, the teacher asks questions to find out what the student does not know in order to find out what needs to be taught. In inquiry instruction, the teacher asks questions in order to model how questioning should be done in order to solve a problem or

accumulate knowledge. The teacher's questions model the process he or she would use to find unknown answers. In other words, the teacher is questioning to find out what needs to be understood. Through the teacher modeling, the student is able to take charge of his or her own learning (Schwab & Brandwein, 1962). Inquiry instruction helps students to become critical thinkers. Instead of being led to the "one correct answer," they are shown how to question one answer in order to discover others (68). Inquiry instruction allows for multiple solutions to a problem and allows multiple students to answer a problem, usually in different ways. Instead of being led to the *one correct answer*, all students are working together towards the "most correct answer" (68). Finally, inquiry instruction provides students with the tools needed to learn in non-traditional settings. They learn to use different resources in order to solve their problems, which is generally what humans must do to function in the real world.

One of the first teaching models for inquiry instruction appeared alongside the research for inquiry instruction. Later titled a "learning cycle," Robert Karplus put forward one of the first models for teaching inquiry. He created, tested, recreated, and presented three phases, that of "exploration, invention, and discovery" (1974/2002, 64). The basic idea was that students explore concepts on their own (exploration). These concepts are then explained in the invention stage. At this time, students have invented new ways to look at and understand the concepts, and the teacher has invented terms to use for the concepts. After students understand more of the concepts (from their own exploration and the extra provided information), they are then able to discover more about a concept or elaborate upon what they already know in the discovery stage. The discovery stage allows students to practice and refine the skills or concepts learned earlier.

The basic three phase teaching model for inquiry instruction proposed by Karplus (1974/2002) has now been expanded, changed, renamed, and copyrighted in all different formats,

eventually leading to the BSCS 5E Instructional Model. Similar to the original model proposed by Karplus, the 5E Instructional Model has stages as well. Instead of three, the 5E Instructional Model has been expanded to contain five different stages, titled the Engagement, the Exploration, the Explanation, the Elaboration, and the Evaluation (Bybee, 2002).

The first stage of the model is the Engagement. The student is hooked in and encouraged to find out more during this first stage. The stage may also include an aspect that ties in with prior student knowledge in order to make the new content more relatable by providing a context that the student is familiar with. Finally, the Engagement is used by teachers as a probe to see what students already know. While students themselves are becoming *engaged* in the activity to follow, teachers are able to observe the students and see where there are gaps in student knowledge. These early observations allow the teacher to tailor the lesson to the students being taught (Bybee, 2002).

In the following stage, the Exploration, students are encouraged to make their own discoveries, continuing with the idea that their own curiosity is a much better way to help them learn. The teacher can “direct” the attention of students in order to make sure important concepts are noticed and discovered by students, however, the Exploration stage is student led. Students ask the questions and explore to find the answers while the teacher acts more as a “facilitator” (Orgill & Thomas, 2007, 41).

The Explanation phase is more teacher directed, but is still based on what the students have discovered on their own in the Exploration phase. Now that students have made the discoveries and had the experiences, the teacher is able to provide the content to go along with the discovery. Explanations can range from complete lecture to teacher-student interactive discussions. Content specific vocabulary is defined during this phase (Orgill & Thomas, 2007).

After gaining the content knowledge to go along with their discoveries, students move into the Elaboration phase. This stage can be similar to the Exploration phase, as students discover concepts for themselves again, but this time, with the background knowledge they have built in the Exploration and Explanation phases. No new information should be introduced during this phase; instead, students should be able to “apply” the information from the earlier stages and piece together all of the information in order to see the newly learned content in a different way (Orgill & Thomas, 2007, 44).

Finally, the Evaluation stage checks to see what students have learned. Student learning can be seen through informal and formal assessment throughout all of the stages or at the end. Students may be required to complete a traditional formal assessment to see learning. They may also be required to create a model or solve open ended problems related to the lesson (Bybee, 2002). The Evaluation phase is important because it allows students to show their understanding of the material. The phase provides teachers with the necessary feedback on whether the lesson was effective, if the lesson should be continued, or if it should be altered before being taught again.

The Players: English Language Learners

Of the total U.S. population in 2011, 12.9% of people over the age of five spoke Spanish or Spanish Creole. That was over a tenth of the population. Of the 12.9%, almost half, 43.7%, spoke English “less than very well” (Ryan, 2013). This 43.7% also included children attending United States schools, which is not a new event, English Language Learners have been in schools of the United States for the last century. English Language Learners in the United States, especially in schools, have been received in many different ways and have therefore experienced many different treatments. There are Latino English Language Learners who succeed, who may

or may not be heard about, but then there are those who do not succeed. Compared with their peers, young Latino students in schools in the United States are faced with some unique challenges.

Starting even before they reach the elementary school, Spanish speaking students are less exposed to a large amount of vocabulary than their peers. This lack of exposure means these students are entering school already behind some of their peers who have been exposed to and have started to amass a large vocabulary (Portales & Portales, 2005). As they continue through school, young Spanish speaking students are confronted by a new language in which they must become proficient, and oftentimes are criticized by teachers for using their native language for any reason. Students are expected to always use the preferred language of the country, English. All students, including English Language Learners, are tested in English, and many are tested using the same test with very few accommodations or modifications. In addition, many tests are “normed on mainstream students,” which means the tests “are not only *not* culture free” but are instead “culture bound” (Suárez-Orozco & Suárez-Orozco, 2001, 144). Students must have knowledge of the dominant culture in order to answer questions correctly. If English Language Learners have not grown up in the United States, or have grown up in a family where their native culture is preserved, students may come into the English test with a disadvantage. These unfavorable factors add up, and by the time students reach college, the “examination scores and other college admissions criteria regularly document the fact that most minority students do not receive K-12 education that allows them to compete evenly with non-Hispanic white college applicants” (Portales & Portales, 2005, 19).

Immigration and varied languages are not new challenges for the United States, nor the schools within the country, yet there is still no perfect solution for how to work with newly

immigrated, non-English speaking students. Much of the general public pushes for “assimilation,” which is when the student replaces his or her own culture with the American culture and is assimilated into society (Rong & Preissle, 1998, 11). In the strictest sense, the newcomer should give up his own culture (including language) completely in order to fit in the new society. At the other end of the spectrum is “multiculturalism” which is when diverse cultures live alongside each other (11). All cultures are promoted and accommodated. One mode of accommodation in the schools is including the native language in the classroom for teaching and learning. However, critics of multiculturalism see the “linguistic skills brought by newly arrived immigrants” and other English Language Learners “as a threat to the integrity of the English language and as a symbolic refusal to accommodate the American culture” (Suárez-Orozco & Suárez-Orozco, 2001, 136). Therefore, some parts of the public are against integrating new cultures and languages into the classroom because they fear that students will not gain English proficiency as fast, or at all. This part of the public sees the alternate language as a problem and that English must be acquired as soon as possible. Yet those who view extra languages through the multicultural lens often see the languages as a “resource” (Gándara & Rumberger, 2009, 763).

While the general public has argued over the best policies for English Language Learners, teachers have already been teaching English Language Learners and finding out what teaching strategies help English Language Learners most in the classroom. Even as early as 1972, Karplus’ hands-on science learning was being used to help science become more accessible for all students. English Language Learners showed greater advances in reading and writing after being taught science through hands-on lessons, showing that hands-on science improves second language acquisition (Peterson, 2002). As the hands-on learning morphed into

inquiry instruction, the strategies used within both continued to be effective with all students; however, this method seems to be especially effective with English Language Learners. The effectiveness could stem from the fact that many characteristics associated with inquiry instruction have also been shown to be good teaching practices when teaching English Language Learners (Lee, Quinn, & Valdés, 2013). While the purposes of the teaching methods in these categories may be different, the methods themselves are similar.

For example, one of the huge components of the Engagement phase in the 5E Instructional Model is activating background knowledge. The students get hooked into the content and connect ideas with concepts they already know. This one strategy is also highly encouraged when teaching English Language Learners. According to the article, “Powerful Learning Tools for ELLs,” English Language Learners “aren’t a blank slate when they enter the science classroom; many have had grade-equivalent schooling, acquiring native language literacy skills in their home countries” (Dong, 2013, 52). Dong’s research refers to adolescent students in the secondary grades, but the same can be true with elementary students. Using previous experiences and creating new shared experiences through the Engagement allows English Language Learners to connect with later content knowledge, which will help English Language Learners access the curriculum and retain more of the learned content information (Dong, 2013).

In addition, inquiry instruction opens up a dialogue between students, allowing English Language Learners to hear models of English from their peers as well as have opportunities to contribute and practice in a place where perfect English is not required. Talking with native English speaking and non-English speaking peers has been shown to teach English Language Learners “as much, if not more, than what they learn from their teachers” (Helfrich & Bosh,

2011, 265). In such environments, students will automatically use their social vocabulary with their peers to start discussing concepts in the Engagement and Exploration, but as they learn the more technical (academic) vocabulary of the subject during the Explanation, they are more likely to learn how to use the vocabulary with their peers during the Elaboration. “Newly acquired words and phrases are best applied in actual real-life situations communicating a need or desire rather than in isolation in one’s head” (Curtin, 2009, 32). Discussion amongst peers throughout the lesson helps English Language Learners on many levels, including, “increasing comprehension levels, which enable the student to process the content of the lesson while acquiring English language skills at the same time. Use of cooperative learning (strategy) for the English Language Learner helps them to develop both communicative and academic content skills” (Curtin, 2009, 93).

Just as a building with ten stories cannot be built in a day, native-like fluency in a language is not built within a day. The building requires an outer framework to help it be built, which often contains scaffolds or supports. In the exact same manner, language acquisition can benefit from scaffolds or supports, usually provided by the teacher. There is a wide range of scaffolds and ways to implement support in lessons, but the basic concept is that scaffolds make the content more accessible for students. Used with English Language Learners, scaffolds often support the student and ensure the student can access the actual content. Teachers provide scaffolds when giving directions by modeling what should happen, or pointing out key features during the instructions. In the 5E Engagement, pictures or real materials are brought in to engage the students non-verbally. When new words are introduced during the Explanation to explain the learned concepts, vocabulary strips are placed on the wall, or students are provided with a note taker with which to follow along. All of these scaffolds allow students to access the actual

content of the lesson, but lessen the demand on language for the students who are learning the language (Curtin, 2009, 129).

Practicing for the Game: Spanish in the Classroom

Due to the long history of immigration in the United States, bilingual education has been involved in the public schools over the years, gaining more public support during some periods than during others. For instance, as early as 1968, the United States passed the Bilingual Education Act of 1968, which “provided financial assistance to local education agencies for the purpose of developing and maintaining new and innovative programs to meet the students who are ELL” (Taylor & Whittaker, 2009, 126). Later, in 1974, the Supreme Court ruled on the case of *Lau v. Nichols*, which supported more bilingual education in the schools, saying schools have “to provide special language programs” (126). As can be seen by the passing of the Bilingual Education Act and the ruling on the *Lau v. Nichols* case, the early 1970s included favorable opinions of bilingual education.

Dr. James Cummins contributed to the public approval of bilingual education through several of his papers, most notably, *The Role of Primary Language Development in Promoting Educational Success for Language Minority Students* (1981). In his research, Cummins presents a definition for language proficiency, some background on bilingual education, and a theory to combat the negative outlooks toward bilingual education. Within his background on bilingual education, Cummins discusses previous negative public opinion about bilingual education, which believed bilingual children were often “confused” and hindered from becoming “good [Americans]” due to their additional language (20). In order to present a counterargument, Cummins discusses different models of bilingual proficiency, titled the “Separate Underlying Proficiency Model (SUP)” and the “Common Underlying Proficiency Model (CUP)” (23-24).

The SUP model presents the idea of two separate balloon like areas in the brain where the native language and English are stored independently. Proficiency in either language requires direct exposure to the respective language. Following the SUP model, content or skills learned in one language are not accessible in the other language. After presenting the SUP model, Cummins claims there is no support for the SUP Model and a model supported by research, the CUP model, must instead be considered. Instead of two balloons with separate proficiency, the CUP model presents one bubble where all knowledge is accessible, despite the language in which it was learned. Since knowledge is stored in one place, the knowledge is transferable across language boundaries, which provides more support for bilingual education.

However, public opinion over bilingual education continued to fluctuate since Cummins' 1981 presentation of the CUP and SUP models, to the 1998 Proposition 227 in California, which is now Education Code 305-306. According to this code, "All children in California public schools shall be taught English by being taught in English. In particular, this shall require that all children be placed in English Language classrooms" (English Language Education). Some exceptions were allowed, but California schools offering bilingual education were severely rearranged due to the original proposition, meaning only 30% of the English Language Learners in schools were provided with bilingual education and certified bilingual teachers only taught 18% of the students (Taylor & Whittaker, 2009, 126).

Even in places where public opinion favors bilingual education, truly bilingual teachers are a rare commodity. To be truly bilingual teachers, teachers must not only know both languages, but also be able to model the language properly for students. California has an "emergency credentialing" procedure that involves recruiting teachers from Spain and South America for Spanish programs. "While these teachers speak Spanish, in some cases their English

skills (grammar, vocabulary, and accent) are inadequate” (Suárez-Orozco & Suárez Orozco, 2001, 141).

Additionally, even after teachers are considered truly bilingual, schools are looking for a specific teacher to fit their program, as there are multiple types of bilingual programs. The article, “Not ‘One Size Fits All,’” lists six types of classrooms with varying levels of bilingual programs. The “English language monolingual programs,” which are otherwise known as mainstream classrooms, are where English Language Learners receive no instruction in their native language and all instruction is in the preferred language (which is usually English) (Honigsfeld, 2009). Moving along a scale of more languages used in the classroom, the second step is an “English-monolingual-plus-ESL program.” This type of program is common in schools; students are taught in English, but are either pulled out for ESL instruction or receive ESL supports in the classroom. As students become more proficient in the preferred language (English), the ESL supports are slowly reduced (Taylor & Whittaker, 2009, 127).

The third step moves into a “transitional bilingual education program,” where students are taught in their native language in the very beginning. The native language is then slowly removed and replaced with the preferred language (English in this case). Eventually all instruction is in the preferred language. The next step is called the “maintenance bilingual program” (Honigsfeld, 2009, 167). Ideally, students will become proficient in both languages as students are instructed equally in the native and preferred languages.

Finally, a “structured immersion program” is usually aimed to help students who are proficient in the preferred language (for instance English), to learn another language (like Spanish) (Honigsfeld, 2009, 167). Structured immersion programs have varying amounts of the second language included in the classroom. While English Language Learners can benefit from

this type of instruction, as long as they know the second language involved, native English speakers are also enrolled in structured immersion programs in order to learn a new language. Instruction may be half in English and half in the other language or certain subjects may be taught in certain languages. All steps along the ladder require special skill sets for the teacher, whether the skill sets are proficiency in the native language of the students or knowing how to best help an English Language Learner.

There are many different ways to help or provide support to an English Language Learner. For instance, some teachers from Spain, involved in a study teaching English Language Learners in California, agreed that “content learned in the primary language facilitates content learning in English” (Ramos, 2005, 418). This is exactly what Cummins discussed in his 1981 research. After being introduced to new content in their “primary language,” students found the information “more comprehensible,” even when working with the content in English, which was the second language (Ramos, 2005, 418). While there are arguments that say learning in multiple languages causes more confusion for students and is detrimental to their learning of English, the teachers involved in the Ramos study believed the Spanish instruction actually facilitated the English acquisition process. The majority of the study teachers agreed on these facts, but there was disagreement about how to continue after students are proficient in English. Ramos found that some of the teachers believed there should be no Spanish supports used after this time, while others thought it fell to the parents to continue using Spanish with students. Still others believed it would be beneficial to continue using Spanish in the classroom with the English proficient students.

Looking at the continued use of Spanish in the classroom, another study examined a modified dual language program in order to see benefits for students. The study by Reyes

worked with native Spanish speaking fourth graders in order to study their discourse patterns, and how English and Spanish were used when given the choice (2008). Students were taught science in Spanish; English was used to clarify a concept if the concept would be more familiar in English. The “code-switching” by the teacher was used to help the students “start making connections with their background knowledge in their L2,” with L2 referring to the preferred language (Reyes, 2008, 105).

While similar to the Ramos study, the Reyes study uses students already proficient in both languages, and then uses Spanish and English to enhance the other. The Ramos study uses the primary language as a support. Something more unique about the Reyes study is that it looks at the discourse patterns of the students as well as the teacher. During the study, the teacher seemed to code-switch less than was anticipated (possibly because she knew she was supposed to teach in Spanish); however, the teacher did intentionally use English when she thought English would help students. The students used English and Spanish intentionally as well. Many think of code-switching as “a social communicative strategy,” and not something used in academic learning, however students were able to use code-switching for “clarification,” “topic change,” “explanation,” “emphasizing important concepts,” and to bring in background knowledge (Reyes, 2008, 107-109). Code-switching allows students to “recognize and identify words that are cognates or are similar in their two languages” (109). Finally, by allowing the use of a native language, or a combination of languages in the classroom, students are able to voice their questions and opinions, even if they do not have the proficiency to do the same in the preferred language. When students are allowed to use multiple languages, they are learning to use the resources they have and in the process learning how to be critical thinkers.

Plan of Attack: The Blended/Tiered Approach to Vocabulary Instruction

While the Three Tiers Framework presented by Beck, McKeown and Kucan (2013) presents the three tiers of words, the framework is presented more as a planning and reference tool for educators and not as a method. More recently, the tiered vocabulary classification system has been combined with the 5E Instructional Model in order to create a Blended/Tiered Approach to Vocabulary Instruction (Crowther, 2013). In the Blended/Tiered approach, different tiers of words are used in different parts of the 5E Instructional Model, scaffolding students' vocabulary from social language into academic vocabulary. While the teacher introduces the concepts in the Engagement and Exploration, tier one and two words are used. After students have had time to familiarize themselves with the concepts in relation to their tier one and two words, tier three words are introduced and compared to the other tiers during the Explanation phase. The Elaboration phase gives students a chance to implement the newly acquired tier three words, as well as connect them to the previously known concepts and lower tiered words. Finally, all tiers and concepts are used in the Evaluation phase in order to show student learning (Crowther, Tibbs, Wallstrom, Storke, & Leonis, 2011).

The Blended/Tiered approach is relatively new, yet the approach has been shown to be effective in vocabulary instruction by improving retention rates of vocabulary, even in classrooms with high percentages of English Language Learners (Crowther, 2013). In addition, the Blended/Tiered approach has been shown to be as effective in a non-traditional two-way-immersion setting (White & Crowther, 2013). The latter study in a two-way-immersion setting class intermixed English and Spanish along with the tiered words and 5E Instructional Model. In the White and Crowther study, several lessons were taught over a period of six weeks. Before beginning, a pre-test was given to the students, testing them on tier three English and Spanish

words as well as concepts. The lessons themselves were a mix of Spanish and English. The Engagements were always in English with a Spanish Exploration and both only used tier one and two words. The Explanation introduced tier three words in both languages and the Elaboration was in English with tier three words. The Evaluations were always in Spanish. After all of the lessons, a post test was given and then four weeks later a post-posttest was given in order to study retention of the tier three words and concepts in both languages. The White and Crowther study mainly focused on the effectiveness of the Blended/Tiered approach in multiple languages in a two-way-immersion class. The approach was shown to be as effective as in a mainstream classroom. However, there has not been any other research performed in order to see the efficiency of the Blended/Tiered approach with multiple languages or in nontraditional classroom, although many of the characteristics of the Blended/Tiered Approach to Vocabulary Instruction overlap with good teaching practices for English Language Learners (Crowther, 2013).

Chapter 3

Methods

Research Design

The Blended/Tiered approach has been shown to be appropriate for all elementary grade levels and learners; however, this study utilized a Quantitative Experimental Design with a control group with a pre/post/post-posttest design in order to look at the effectiveness of the approach in a bilingual setting. The study was conducted in two classrooms in the Western United States, both with high percentages of English Language Learners. The study aimed to compare effectiveness of the Blended/Tiered approach through knowledge gain and retention rates when the Blended/Tiered Approach was used in an English only setting compared to an English setting with Spanish Supports.

This study utilized the Blended/Tiered Approach to Vocabulary Instruction for a unit of elementary science including six lessons covering the third-grade standards for Earth Science. After discussing the topics and specifics with the teachers, the researcher planned lessons according to the Next Generation Science Standards, which are the current piloted standards used in the school district. The specific standards used in the lessons covered measuring weather and comparing weather to climate, see Figure 2 (NGSS Lead States, 2013).

Students who demonstrate understanding can:

3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. [Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] [Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]

3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.

Figure 2. Next Generation Science Standards, 3-ESS2 Earth's Systems. This figure shows the standards used in the lessons. From *Next Generation Science Standards: For States, By States*, by NGSS Lead States, 2013.

Teachers teach science content in various ways, but the Next Generation Science standards provide guideposts for what students need to know, therefore, the research planned six lessons at the third-grade level following the two standards in Figure 2. All lessons in both classes utilized the Blended/Tiered Approach to Vocabulary Instruction as designed by Crowther (et al, 2011). In addition, all lessons used “innovative teaching practices,” designed to allow students to be “actively involved in learning” (Curtin, 2009, 72). The lessons allowed for conversations between students and teachers as well as students with other students, maximizing the benefits of conversation in language learning.

Before the lessons were taught, parental consent forms were sent home in English and Spanish with an initial letter introducing the researcher and the study to parents. The researcher read a script to the students before the pretest in order to gain their verbal assent. The script explained the study to both classes in third-grade terminology. The study was explained the exact same way in both classes except one class was told they would have English and Spanish lessons while the other class was informed that they would only have English lessons. All parents and students had the option of not allowing a student’s data used in the study, following Institutional Review Board expectations.

Students in the two classes were then given the same pretest within their respective classes. The pretest covered important material that was cumulative in the unit of instruction (see Appendix F). All test questions were written in English and Spanish. Students were able to answer in either language and were encouraged to answer in both languages. Before starting the test, students were assured that the test was not graded and they were informed that the pretest was for a class project for the researcher. The researcher explained that the pretest would be compared to two later tests in order to see if the students learned from the lessons. The researcher

read the test aloud in both classes in order to eliminate literacy ability from the results.

In the four weeks following the pretest, students were able to participate in six lessons on weather taught by the researcher. Each lesson used the Blended/Tiered approach to introduce two or three scientific words, therefore, each scientific word was scaffolded to lower tiers of words as seen in Appendices A-E. For example from Appendix A, students were first introduced to the phrase *heavy air*, since most know they breathe air and they know what heavy is. By relating heavy air to prior experiences, students were able to access the phrase *air pressure*, which was then tiered into *barometric pressure*. During these lessons, the control class received all vocabulary in English, while the experimental class received the English vocabulary as well as the Spanish vocabulary. All five of the lessons that were written and taught by the researcher are included in Appendices A-E and are written for ease of repeatability by other teachers. Key features of each lesson include the standards covered; a chart showing key vocabulary with lower tiered words; materials required; necessary background knowledge; all five phases of the 5E Instructional Model with step by step instructions; and any attachments needed to teach the lesson.

The lessons are ordered as they were taught, starting with an *Introduction to Weather and Atmospheric Pressure* lesson (Appendix A). The *Introduction to Weather and Atmospheric Pressure* lesson served as an informal assessment of student prior knowledge as well as an introduction to the rest of the unit. The lesson introduced extreme weather as well as the four main parts of weather, which were covered more in depth throughout the lessons and included precipitation, wind, barometric pressure, and temperature. The first lesson finished with an activity on barometric pressure where students made a classroom barometer. The second lesson, titled *Temperature*, is included in Appendix B. In this lesson, students learned about temperature

by exploring and experiencing thermometers, eventually making their own. Appendix C contains the third lesson, *Wind Direction*, which used a windy day or fans to explore wind through pinwheels. Students finished by making an instrument to measure wind, an anemometer. Lesson four, *Clouds, Precipitation, and Humidity*, covered the fourth aspect of weather, the water component (Appendix D). Students focused on clouds through a cloud experiment and a cloud hunt, while precipitation and humidity were introduced in relation to clouds. The first four lessons (Appendices A-D) set the stage for the longer fifth and final lesson, *Climate Versus Weather (Engineering Too)* found in Appendix E. As a result of the first four lessons, students were familiar with weather and used that information to compare and contrast weather and climate. After creating a definition of climate, students learned more about global climates and put all of that information to use in order to engineer a house that could endure a tropical climate.

Following the six lessons discussed, a posttest was given (see Appendix F). The posttest was the same test as the pretest and was once again read to the students in order to eliminate any levels of literacy. This time the test was graded, as the test was used as a classroom grade for the unit of instruction. Answers were accepted in English or Spanish. Twenty five days after the posttest was given, the post-posttest (using the same assessment instrument from Appendix F) was given. Once again the test was read to students, and answers were accepted in either language. The final test was not for a grade in the classes. The hope was that by scaffolding academic language in both English and Spanish in the experimental group, pretest to posttest scores would show a learning gain. In addition, it was hoped that retention would be seen by a lack of significant drops of scores from the posttest to post-posttest experimental scores.

Subjects

This study took place in two third-grade classes in a school district in the Western United

States. As of 2013, 16.4% of the students in the district were considered to have Limited English Proficiency. The school involved in the study was a Title I school and considers 48.7% of its 308 students as English Language Learners ("Demographic profile: Year," 2013). The third-grade control class was comprised of 22 students, with 13 classified as Limited English Proficiency. The third-grade experimental class had 23 students, with 13 classified as Limited English Proficiency as well. All students classified as English Language Learners used Spanish as their alternate language. The teachers of both classes planned together and therefore moved at comparable paces, allowing the same content to be taught in both classes. Due to parental consent and student assent procedures, the population size for the control class was reduced to 16 students, while only 14 students from the experimental class participated in the study.

Instruments and Materials

This research implemented a teacher created assessment with construct validity, but no reliability figures calculated, as this study was the first use of the assessment. The same assessment was used for the pretest, posttest, and post-posttest and was based on knowledge to be taught in the lessons. The ten assessment questions were written in English and Spanish and included a variety of types of questions. The given assessment as well as a key with grading notes are included in Appendix F and Appendix G. Questions one through four on the assessment were basic matching. Students were given a word box with the four words in English and Spanish. Students had to write the correct word (in either or both languages) to receive credit. On question five, students could earn up to four points. One point was earned by filling in the first blank, naming the pictured instrument (anemometer or anemómetro). For the other three points, students described how the instrument works. On question six, students could earn a possible two points for information on a thermometer and temperature. Question seven was

matching, and students earned one point for each correctly matched term to the proper cloud picture. Questions eight, nine and ten were open ended. For number eight, students were given some example options, but could also supply their own. There were a possible two points. Students were given a point for listing two elements that could possibly work together and another point for giving a valid reason they work together. Question nine gave students a picture of a house and they had to justify why the house was good for a desert climate. Students received one point per response for a total of two points. The final question was worth four points. Students received one point for a picture of an element of weather, however, the picture had to be of weather, and not of a season. They then received another point for labeling what type of weather they drew (labels appeared in the drawing and in the explanation). Finally, all responses were accepted as long as the response related to liking a certain type of weather. The fourth point was earned by writing an instrument that could measure the type of weather shown. Snow and sun were not measured by a thermometer unless the explanation or picture included something about the temperature as well.

Data Collection Procedure

A quantitative pretest, posttest, and post-posttest design was used to show change and growth in student knowledge in two classes as well as retention of content learned using the Blended/Tiered approach in English only versus English with Spanish supports in vocabulary instruction. Tests were created and graded by the researcher according to the attached scored test with notes (see Appendix G). Scores were collected from all three tests and both classes. All 45 students were assigned a number that was used in the spreadsheet for scores. Tests were given a raw score, which included all correct answers (in any language). Students could receive a total of twenty-one points. Languages used were also noted. Students then received a *value-added* score.

The value added score was the base amount correct (out of twenty-one), plus those correct in English (out of eighteen), plus those correct in Spanish (out of eighteen). Therefore, if students answered all questions correctly in both languages, they could receive a value added score of fifty-seven points. Tests were stored in a locked file cabinet until returned to the students.

Data Analysis

Since there were more than two data sets, data sets were analyzed using an analysis of variance (ANOVA) with a multiple comparisons test at an alpha value of $p \leq 0.05$. Differences were noted between the respective time points in the two classes in order to see the effectiveness of the approach with or without Spanish supports. Data also compared time points in order to look at retention. While the ANOVA was used to find significant differences, the Tukey Kramer Multiple Comparisons Test was used to find out where those significant differences were located within the data. To look for practical significance, an Effect Size Analysis was performed instead of a meta-analysis. The Effect Size Analysis was used with selected results in order to see if they truly showed a difference in data, or if the differences were insignificant. “Effect size is a means for identifying the strength of conclusions about group differences or about the relationship among variables in a quantitative study” (Creswell, 2002, 248). Since a lot of educational research uses small sample sizes, the Cohen’s *d* calculation is often used (Cohen, 1988). Typically, the difference between the mean score of the control data and the experimental data is divided by the standard deviation of the scores of the control group in order to find effect size (Borg, Gall & Gall, 1993 171). The Cohen’s *d* calculation uses a pooled standard deviation instead of the standard deviation of the control group. From this calculation, effect sizes of 0.0 to 0.2 are small, 0.3 to 0.5 are medium, and anything larger than 0.6 is large (Cohen, 1988). In relation to practicality, “an effect size of 0.33 or larger is generally considered to indicate a

difference that has practical significance” (Borg, Gall & Gall, 1993, 171). Overall, effect size “transforms the results from various studies into a comparable unit of measure” (171).

Chapter 4

Results

Data were collected from the pretest, posttest, and post-posttest for all students in both classes. Two analyses of variance (ANOVA) were then used to compare the multiple sets of data. The first data set consisted of the multiple raw scores of all students. Raw scores were based on the amount of correct answers. Correct answers were accepted in any language and the total possible points was twenty-one. Table 1 shows group designations, the group means, standard deviations of scores, and the number of students involved in each group of the first data set (raw scores). Groups were made for each category of data: the control pretest, control posttest, control post-posttest, experimental pretest, experimental posttest, and experimental post-posttest.

Table 1: Group Means and Standard Deviations of Raw Scores

| Group | | | Mean | Standard Deviation | Number of Students |
|-------|--------------|---------------|---------|--------------------|--------------------|
| 1 | Control | Pretest | 6.4375 | 1.5042 | 16 |
| 2 | Control | Posttest | 12.25 | 3.2762 | 16 |
| 3 | Control | Post-posttest | 9.75 | 2.6328 | 12 |
| 4 | Experimental | Pretest | 6.5 | 2.3452 | 14 |
| 5 | Experimental | Posttest | 11.5714 | 3.797 | 14 |
| 6 | Experimental | Post-posttest | 15.5714 | 13.0249 | 14 |

Based on the raw data used for the first set of comparisons, Table 2, the Analysis of Variance of Raw Scores Table, shows the Alpha (P) is less than 0.001. When P is less than or equal to 0.05 there is a statistical difference somewhere within the data. According to Table 2, there is a statistical difference in the data and any alpha value within the data that is smaller than 0.001 is significant.

Table 2: Analysis of Variance of Raw Scores

| Source | S.S. | DF | MS | F | Appx P |
|-----------|---------|----|-------|------|--------|
| Total | 3652.52 | 85 | | | |
| Treatment | 916.98 | 5 | 183.4 | 5.36 | < .001 |
| Error | 2735.55 | 80 | 34.19 | | |

Table 2 shows the ANOVA found a significant difference in the data, therefore, Table 3, the Tukey Kramer Multiple Comparisons Test with Raw Scores, pinpoints where the significant difference(s) are between the groups. The group numbers referred to in Table 3 are those listed in Table 1.

Table 3: Tukey Kramer Multiple Comparisons Test with Raw Scores

| Groups Compared | Difference | P-Value | Simultaneous 95% Confidence Limits |
|---------------------|------------|---------|------------------------------------|
| Mean (6) – Mean (1) | 9.1339 | <.001 | (2.8681, 15.3998) |
| Mean (6) – Mean (4) | 9.0714 | 0.001 | (2.8869, 15.256) |
| Mean (6) – Mean (3) | 5.8214 | 0.200 | (-0.229, 11.8719) |
| Mean (6) – Mean (5) | 4.0 | 1.000 | (-1.2894, 9.2894) |
| Mean (6) – Mean (2) | 3.3214 | 1.000 | (-0.9448, 7.5876) |
| Mean (2) – Mean (1) | 5.8125 | 0.093 | (0.0274, 11.5976) |
| Mean (2) – Mean (4) | 5.75 | 0.132 | (0.1215, 11.3785) |
| Mean (2) – Mean (3) | 2.5 | 1.000 | (-2.8442, 7.8442) |
| Mean (2) – Mean (5) | 0.6786 | 1.000 | (-3.5876, 4.9448) |
| Mean (5) – Mean (1) | 5.1339 | 0.281 | (-0.4946, 10.7624) |
| Mean (5) – Mean (4) | 5.0714 | 0.366 | (-0.218, 10.3609) |
| Mean (5) – Mean (3) | 1.8214 | 1.000 | (-2.7646, 6.4074) |
| Mean (3) – Mean (1) | 3.3125 | 1.000 | (-2.0317, 8.6567) |
| Mean (3) – Mean (4) | 3.25 | 1.000 | (-1.336, 7.836) |
| Mean (4) – Mean (1) | 0.0625 | 1.000 | (-4.2037, 4.3287) |

Since some alpha values were close, for instance, the comparison between the control pretest (group labeled 1) and the control posttest (group labeled 2) with an alpha value of 0.093, Effect Size Analyses were used to see practical significance between some of the comparisons from the Tukey Kramer Multiple Comparisons Test (see Table 4).

Table 4: Effect Sizes of Selected Raw Scores

| Effect Size Calculation | Groups compared | Mean | Group Standard Deviation | Effect Size |
|-------------------------|---------------------------|---------|--------------------------|-------------|
| 1x2 | Control pretest (1) | 6.4375 | 1.5042 | 2.28019 |
| | Control posttest (2) | 12.25 | 3.2762 | |
| 1x3 | Control pretest (1) | 6.4375 | 1.5042 | 1.54494 |
| | Control post-posttest (3) | 9.75 | 2.6328 | |
| 4x5 | Experimental pretest (4) | 6.5 | 2.3452 | 1.60704 |
| | Experimental posttest (5) | 11.5714 | 3.797 | |

The final comparison made with the raw scores was between the control and experimental post-posttests. As this comparison was across classes, a pooled effect size was used (see Table 5).

Table 5: Pooled Effect Size of Raw Post-posttest Scores

| Effect Size Calculation | Groups compared | Mean | Standard Deviation | Combined Mean | Combined Standard Deviation | Effect Size |
|-------------------------|--------------------------------|---------|--------------------|---------------|-----------------------------|-------------|
| 3x6 | Control pretest (1) | 6.4375 | 1.5042 | 3.3125 | 1.1286 | 0.75837 |
| | Control post-posttest (3) | 9.75 | 2.6328 | | | |
| | Experimental pretest (4) | 6.5 | 2.3452 | 9.0714 | 10.6797 | |
| | Experimental post-posttest (5) | 15.5714 | 13.0249 | | | |

The same analyses were done with the second set of data, or the *value-added* scores. These scores were out of fifty-seven points. Students were awarded points for the base amount of questions correct (out of twenty-one), the questions correct in Spanish (out of eighteen), and the questions correct in English (also out of eighteen). Table 6, the Group Means and Standard Deviations of Value-Added Scores, shows group designations, the group means, standard deviations of scores, and the number of students involved in each group of the second data set, with the groups once again defined.

Table 6: Group Means and Standard Deviations of Value-Added Scores

| Group | | | Mean | Standard Deviation | Number of Students |
|-------|--------------|---------------|---------|--------------------|--------------------|
| 1 | Control | Pretest | 12.0625 | 2.5158 | 16 |
| 2 | Control | Posttest | 22.0 | 6.2716 | 16 |
| 3 | Control | Post-posttest | 18.0 | 4.899 | 12 |
| 4 | Experimental | Pretest | 11.7857 | 4.0796 | 14 |
| 5 | Experimental | Posttest | 21.5 | 7.1764 | 14 |
| 6 | Experimental | Post-posttest | 21.8571 | 5.4893 | 14 |

Table 7, the Analysis of Variance of Value-Added Scores Table once again indicates there is a statistical difference somewhere in the data.

Table 7: Analysis of Variance of Value-Added Scores

| Source | S.S. | DF | MS | F | Appx P |
|-----------|---------|----|--------|-------|--------|
| Total | 3964.38 | 85 | | | |
| Treatment | 1737.87 | 5 | 347.58 | 12.49 | < .001 |
| Error | 2226.51 | 80 | 27.83 | | |

Since there is a significant difference in the data, a Tukey Kramer Multiple Comparisons Test was performed in order to see where in the data are the significant differences, which can be seen in Table 8, the Tukey Kramer Multiple Comparisons Test with Value-Added Scores.

Table 8: Tukey Kramer Multiple Comparisons Test with Value-Added Scores

| Groups Compared | Difference | P-Value | Simultaneous 95% Confidence Limits |
|---------------------|------------|---------|------------------------------------|
| Mean (2) – Mean (4) | 10.2143 | < .001 | (4.5614, 15.8672) |
| Mean (2) – Mean (1) | 9.9375 | < .001 | (4.7183, 15.1567) |
| Mean (2) – Mean (3) | 4.0 | 0.758 | (-1.2988, 9.2988) |
| Mean (2) – Mean (5) | 0.5 | 1.000 | (-4.1204, 5.1204) |
| Mean (2) – Mean (6) | 0.1429 | 1.000 | (-3.706, 3.9917) |
| Mean (6) – Mean (4) | 10.0714 | < .001 | (4.4919, 15.651) |
| Mean (6) – Mean (1) | 9.7946 | < .001 | (4.7167, 14.8725) |
| Mean (6) – Mean (3) | 3.8571 | 1.000 | (-1.1097, 8.824) |
| Mean (6) – Mean (5) | 0.3571 | 1.000 | (-3.6179, 4.3322) |
| Mean (5) – Mean (4) | 9.7143 | < .001 | (4.4699, 14.9587) |
| Mean (5) – Mean (1) | 9.4375 | < .001 | (4.8171, 14.0579) |
| Mean (5) – Mean (3) | 3.5 | 1.000 | (-0.6374, 7.6374) |
| Mean (3) – Mean (4) | 6.2143 | 0.055 | (1.2475, 11.1811) |
| Mean (3) – Mean (1) | 5.9375 | 0.063 | (1.9212, 9.9538) |
| Mean (1) – Mean (4) | 0.2768 | 1.000 | (-3.5721, 4.1256) |

Once again, the Tukey Kramer Multiple Comparisons Test (Table 8), returned data with close alpha numbers; therefore, an Effect Size Analysis was used again in order to see practical significance among the value-added post-posttest scores (see Table 9).

Table 9: Pooled Effect Size of Value-Added Post-posttest Scores

| Effect Size Calculation | Groups compared | Mean | Standard Deviation | Combined Mean | Combined Standard Deviation | Effect Size |
|-------------------------|--------------------------------|---------|--------------------|---------------|-----------------------------|-------------|
| 3x6 | Control pretest (1) | 12.0625 | 2.5158 | 5.9375 | 2.3832 | 2.11137 |
| | Control post-posttest (3) | 18.0 | 4.899 | | | |
| | Experimental pretest (4) | 11.7857 | 4.0796 | 10.0714 | 1.4097 | |
| | Experimental post-posttest (5) | 21.8571 | 5.4893 | | | |

Chapter 5

Discussion

Conclusion

The Blended/Tiered Approach to Vocabulary Instruction has been shown to be successful in English Only mainstream classrooms (Crowther, Tibbs, Wallstrom, Storke, & Leonis, 2011). In addition, White and Crowther (2013) showed that the Blended/Tiered Approach to Vocabulary Instruction could also be effective in English and Spanish in a two-way-immersion setting. This study combined the ideas of the research from White and Crowther (2013) and Crowther et al. (2011), and looked at the Blended/Tiered Approach to Vocabulary Instruction in a mainstream classroom in English *and* Spanish with a high percentage of English Language Learners. Contrary to many criticisms of bilingual education as mentioned by Cummins, which suggest children are confused by multiple languages in the classroom and are less likely to learn, the data from this research suggest that students are not confused by the addition of Spanish in the classroom and may instead retain information longer than students exposed to the same content in English only (1981).

Group Means and Standard Deviations. The group means and standard deviations for both data sets are shown in Table 1 and Table 6. The very first data table, Table 1, Group Means and Standard Deviations of Raw Scores, shows the difference in mean scores. Both classes started out by receiving mean raw scores of 6.4 out of 21 (control) and 6.5 out of 21 (experimental). These scores show the classes started at about the same level of prior knowledge before any of the lessons. After the lessons were taught, the posttests showed similar gains in knowledge. The control class had a slightly larger gain in points, of 5.9 points, or from 6.4 to 12.3. The experimental class gained 5.1 points, or moved from 6.5 to 11.6 points. The larger

jump occurred with the post-posttest, which can be seen in Figure 3. While the mean score from the control class dropped from 12.3 to 9.8, the mean score in the experimental class went up, from 11.6 points to 15.6. Both classes showed growth from the pretest to the posttest, meaning all students gained knowledge since the beginning of the lessons. However, the experimental class (dashed line) not only learned the material, but retained the material until the post-posttest in addition to improving their scores from the posttest to the post-posttest.

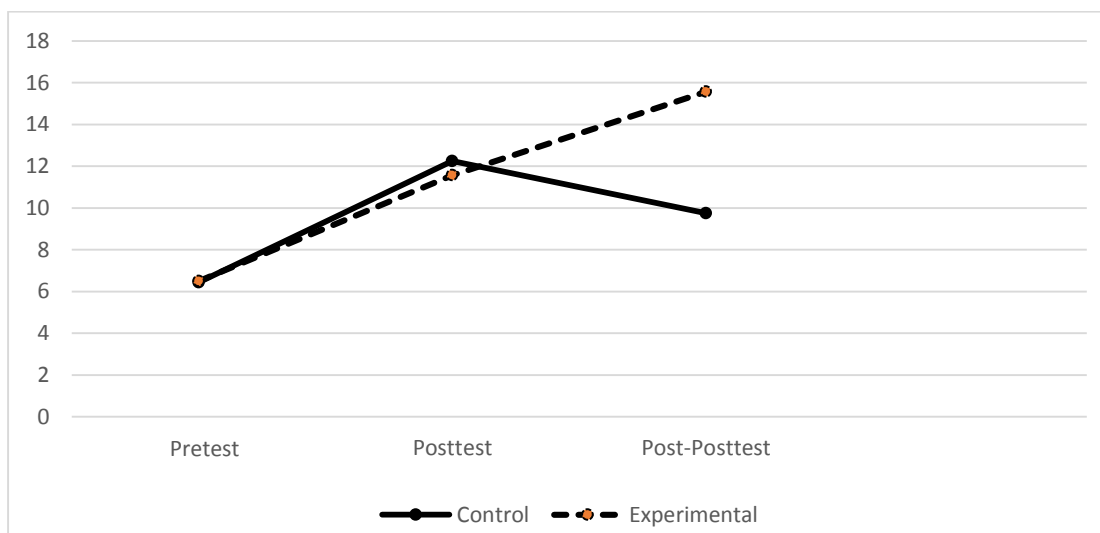


Figure 3. Graphical Representation of Group Means and Standard Deviations of Raw Scores. This figure graphically represents the raw mean scores from the control and experimental pretest, posttest, and post-posttest as seen in Table 1.

Similar gains were made when looking at the value-added scores. Referring back to Table 6, the Group Means and Standard Deviations of Value-Added Scores, the control class started at 12.06 points out of 57 on the pretest. They jumped to 22.0 points on the posttest, a growth of 9.9 points. The experimental class started at 11.8 points and jumped to 21.5 points, a gain of 9.7 points. Once again, the classes started out with similar point amounts on the first test and gained approximately the same number of points on the posttest. The value-added post-posttest scores also show similar changes to the raw scores. As can be seen in Figure 4, both classes started out

with similar pretest scores, approximately 12 points. Both classes then experienced a 9.8 point gain in the posttest. However, as can be seen in the raw scores represented in Figure 2, students in the experimental class retained the same information until the post-posttest, even raising the score slightly, from 21.5 points to 21.8571. On the other hand, the control class did experience a growth in scores from the pretest to the posttest, but then had a loss of four points from the posttest to the post-posttest. In other words, all students learned some material from the beginning of the unit until the end of the unit and the posttest, however, the control class did not retain as much information from the posttest to the post-posttest as the experimental class retained.

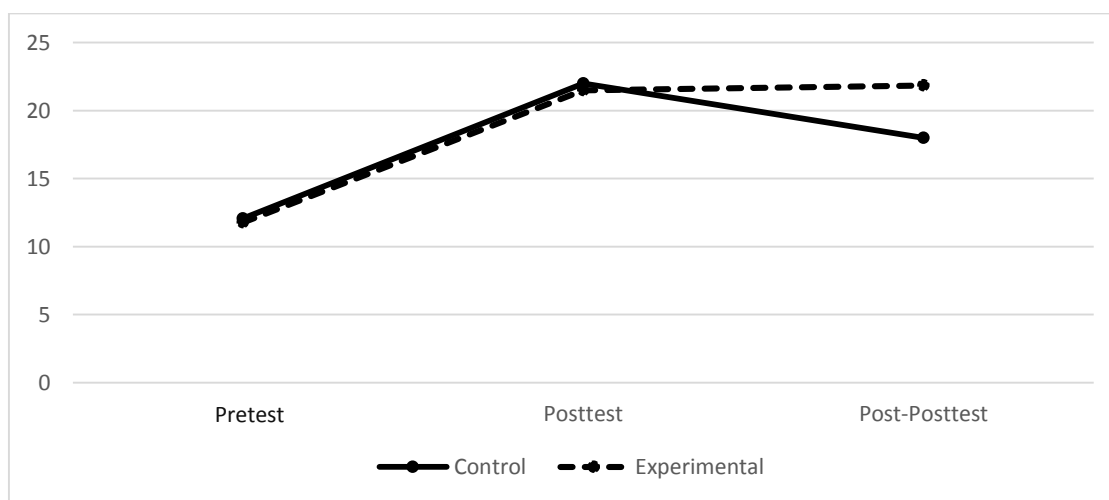


Figure 4. Graphical Representation of Group Means and Standard Deviations of Value-Added Scores. This figure graphically represents the value-added mean scores from the control and experimental pretest, posttest, and post-posttest as seen in Table 6.

Tukey Kramer Multiple Comparisons Tests and Effect Size Analyses. The mean scores previewed the data, but the Tukey Kramer Multiple Comparisons Tests (Tables 3 and 8) showed more of where the differences were located within the data. In addition, Effect Size Analyses were used to determine practical significance (Tables 4, 5, and 9). Table 3, the Tukey Kramer Multiple Comparisons Test with Raw Scores confirms what was shown by Figure 3 with

the p-value between the control posttest and post-posttest not significant at 1.00, meaning the students did not lose too much information from the end of the unit until the post-posttest. The mean scores between the pretest and posttest and the pretest and post-posttest are not considered statistically significant by the Tukey Kramer Multiple Comparisons Test; however, since the means (Table 1) show a difference in data, an Effect Size Analysis was run between the control pretest and control posttest scores as well as one between the control pretest and control post-posttest scores. As seen in Table 4, the effect size between the control pretest and control posttest was 2.28019, while the effect size between the control pretest and control post-posttest was 1.54494. According to Cohen, these are both large effect sizes (1988). Borg, Gall, and Gall mention that anything larger than 0.33 is considered to have practical significance (1993). Consequently, the Effect Size Analyses coincide with the mean scores to show that there was a practical difference in the data.

While the mean scores did show a growth from pretest to posttest with respect to the experimental group's raw scores (see Figure 3), the Tukey Kramer Multiple Comparisons Test (Table 3) did not show a statistical significance since the p-value was 0.366. Therefore, an Effect Size Analysis was used to look for practical significance. With an effect size of 1.60704, there was a practical significance between the experimental pretest raw scores and the experimental posttest raw scores (Table 4). There was once again no statistical difference between the post and post-posttest, showing that students retained information, but there was a statistical difference between the pretest and the post-posttest for the raw scores of the experimental group. This statistical difference (with a p-value of 0.001) shows that students did learn between the pretest and post-posttest.

The final comparisons for the raw data were made between the control and experimental

pretest, the control and experimental posttest, and the control and experimental post-posttest. For the pretest, the Tukey Kramer Multiple Comparisons Test (Table 3) shows there was no statistical difference between the control and experimental groups (p -value = 1.00), showing that both classes started out with similar levels of information, just as was seen in Figure 3 of the mean scores of raw data. Similarly, there was no statistical difference between the posttest scores of the control and experimental groups, both classes learned the material. Finally, there was not a statistical difference between the post-posttest scores between the two groups, as the p -value is 0.2, however, referring to Figure 4, a difference in mean scores can be seen, therefore, another Effect Size Analysis was used (Table 5). The effect size between the control and experimental post-posttests was 0.75837. As 0.75837 is greater than 0.6, Cohen considers the effect size large (1988). Since 0.75837 is larger than 0.33, there is a practical difference (Borg, Gall & Gall, 1993).

Moving into the value-added data, the results were once again similar to those previewed by Figure 4 of the Graphical Representation of Group Means and Standard Deviations of Value-Added Scores. For the control group, there was a significant difference between the pretest and the posttest, students did learn (p -value is $< .001$). However, there were no significant differences between the posttest and post-posttest or the pretest and post-posttest. In other words, while the scores were a bit lower in the post-posttest compared to the posttest, the loss of points was not significant. Since those post-posttest scores were lower than the posttest, they were closer to the pretest scores. While students did show a small growth from the pretest to the post-posttest, overall, in the control group, for value-added scores, there was not a significant difference between the pretest and the post-posttest.

The experimental group did show a significant difference from pretest to posttest and

pretest to post-posttest. With both p-values at $< .001$, students learned from the pretest to the posttest, and retained the knowledge in order to continue to show a significant difference from the pretest to the post-posttest. With a p-value of 1.0, there was no significant difference between the posttest and post-posttest, which means students in the experimental group did retain the learned information.

The means in Figure 4 continue to be explained when the final comparisons of the value-added scores from the Tukey Kramer Multiple Comparisons Test (Table 8) are examined. The p-values of the control and experimental pretest as well as the control and experimental posttest are both 1.00, signifying no statistical difference. Just as was seen with the means, both classes started out with a similar amount of prior knowledge, and both classes learned a similar amount. Figure 4 also shows a substantial difference between the post-posttest scores of the groups, therefore, an Effect Size Analysis was used, since the Tukey Kramer Multiple Comparisons Test did not show a significant difference in the value-added scores. The effect size was shown to be 2.11137 for the value-added post-posttest scores, thus the effect size showed practical significance.

Discussion

Critics of bilingual education believe using a student's native language in the classroom devalues English and eliminates the need for students to learn English. In addition, critics believe that Spanish added to the classroom will confuse students (Suárez-Orozco & Suárez-Orozco, 2001, 136). Contrary to popular belief, in this study, both classes started at a similar level of knowledge and attained a similar amount of knowledge. Both the raw scores data, Table 3, and the value-added scores data, Table 8, show no significant difference when the pretest and posttest scores are compared. All of the p-values are greater than 0.001, signifying that the differences

are not significant, confirming that the two classes started at a similar level of knowledge and gained a similar amount of knowledge from the lessons. One of the large differences in the study appeared in relation to the retention of the material between the classes.

In both sets of data on the control group, there was no significant difference between the pretest and post-posttest. Looking at Table 3, the alpha value between the raw scores control post-posttest and pretest [Mean (3) – Mean (1)] was 1.000, not significant. Similarly, Table 8 shows the value-added control data. Between the post-posttest and pretest [Mean (3) – Mean (1)] there was a p-value of 0.063, also not significant. As can be seen by the Effect Size Analyses in Table 4, there was a practical difference between the pretest and the post-posttest for the control group, reiterated by Figure 3 and Figure 4, which show a visible gain in points from the pretest to post-posttest. Therefore, students did learn and retain some information, but the retained information was not enough to be statistically significant.

On the other hand, the pretest and post-posttest scores (raw and value added) were significantly different for the experimental groups, as both had p-values of .001 or < .001. As can be seen by Figure 3 and Figure 4, the post-posttest mean scores were dramatically higher than the pretest scores, which is reflected by the statistically significant differences. Just as in the Reyes study, the two languages used in conjunction with each other were able to enhance the learning, allowing students to integrate the information more fully into their knowledge base, which was shown in their retention during the post-posttest (Reyes, 2008).

There were several instances throughout the lessons where the enhanced learning was visible. For instance, since vocabulary was written and placed on the wall, students noticed the similarities between many of the words introduced in English and Spanish during the lessons. For example, as seen in Appendix C, *anemómetro* and *anemometer*. Even the students who did

not recognize the term recognized that the two were similar. The word connection between English and Spanish, also known as cognates, helped to lead a discussion on English words one day when a student came in and asked about a humidifier. Since the students had seen the connections between the English and Spanish words previously, the students were able to make the connection between humidifier, which was unfamiliar, and humidity, which they compared to *wetness*, as the word was tiered in our lessons (see Appendix D). Since many students already code-switch in their daily conversations and often use it as a strategy to “identify words that are cognates or are similar in their two languages,” they were able to use a similar strategy to figure out an unfamiliar (but similar) word in one language, English (Reyes, 2008, 109).

The concept of enhanced learning can be seen in some of the answers from the tests. Looking at Appendix F, question number six is “Describe how it would feel outside when the liquid in a thermometer moves up” or “Describe como se sentiría afuera cuando el líquido en un termómetro mueve arriba.” One student was able to answer “muy caliente” in Spanish, meaning *muy caliente*, or *very hot*. The answer is true, no matter what language is used. The student knows the content, although may not have been able to demonstrate the knowledge if a Spanish answer was not accepted. Since the student was already aware of the *concept* that a thermometer would move up when it is very hot outside, the English vocabulary may have been more accessible when it was discussed in class. Consistent with Cummins’ CUP model, all knowledge is accessible, no matter what language it was learned in (1981).

Other answers on the test also demonstrated a combination of Spanish and English, showing the natural code-switching used by bilingual students, which they are penalized for in a standard setting (Portales & Portales, 2005). However, code-switching can be used for “clarification,” “topic change,” “explanation,” “emphasizing important concepts,” and to bring in

background knowledge as seen in the Reyes study (2008, 107-109). For instance, when answering question five, which asks how an anemometer works (Appendix F), one student responded, “It moves when there are viento” with viento translating to wind. Once again, the answer was acceptable. There were three other students who also replaced the English word “wind” with the Spanish word “viento”. For these students, the extra support of Spanish in the lessons provided the needed “bridge” for students to connect the information (Ramos, 2005, 411).

Although much of the data is supported by the literature and supports the literature, there is some data that does not tell the complete story. For instance, following Table 3, there was no statistical difference between the control pretest and the control posttest for the raw scores, as the p-value is 0.093. A similar case can be seen between the experimental pretest and posttest scores as well, with a p-value of 0.366. Yet, by looking at the mean scores of the pretest and posttest for both the control and experimental raw data, a difference can be seen. The Tukey Kramer Multiple Comparisons Test reflects the difference with the value added scores. Small sample sizes affected some of these scores, which is why the Effect Size Analyses were used when the data was close.

While some of the multiple comparisons tests compared populations of 14 to 16 students (see N in Table 1 and Table 3), other comparisons related populations with only 12 students. Statistical differences can be seen in larger populations with smaller differences between mean scores, however, smaller populations require larger differences in order to see statistically significant differences. Small population size is why the Tukey Kramer Multiple Comparisons Test shows no statistical difference between the raw experimental pretest and posttest and no difference between the posttest and post-posttest, but there is one between the pretest and post-

posttest. As seen by Figure 3, the population size is small enough that the difference between pretest and posttest scores is not significant. The difference from the posttest to post-posttest scores is small enough that the difference is also not significant. However, in this case, those two non-significant differences are large enough together to make a significant difference in the raw experimental pretest to post-posttest. It would be interesting to see a similar layout of scores with a larger population size, where smaller differences would still be statistically significant. This study was required to have Institutional Review Board approval before starting. Part of the Review Board process required parent consent and student verbal assent to have data used in the study. Therefore, while both classes were composed of a larger population, only the data of the smaller populations that gave consent and assent was used.

In the case of the experimental scores, for raw and value-added data, the post-posttest scores were both significant compared to the pretests. Figure 3 and Figure 4 show a drop in mean scores from the control posttest to the post-posttest. This drop in scores follows the idea that information is partially forgotten after being studied. There was still a gain in information from the beginning of the lessons to the post-posttest, but there was a slight drop from the posttest to the post-posttest, which is supported by the lack of significant difference between the pretest and post-posttest in either data set. On the other hand, the experimental class did show a gain in information from the pretest to the post-posttest with statistically significant differences in both data sets. While not statistically significant between the posttest and post-posttest, the mean scores (Figure 3 and Figure 4) of both experimental data sets show a growth. Instead of forgetting the information, students in the experimental class seemed to better understand the material.

This follows Curtin's view of learning language. In a foreign language, language is better

learned in a social situation instead of in “isolation” (Curtin, 2009, 32). Scientific vocabulary is similar to a foreign language, even for English speakers. For instance, “anemometer” is not a word most adults use, let alone third-graders. Yet, after learning about wind and anemometers in a lesson, students were able to point to and identify an anemometer on a building while on a field trip. The students were able to use their new vocabulary realistically, which helped to strengthen the learned information.

Questions for Future Research

The question was already considered, how would the data from this research differ if the population sizes were larger? Statistical differences would be more apparent, even with small gaps in scores, but expanding the population size would also bring other questions into consideration. For this research, all lessons in both classes were taught by the researcher, who only taught the science lessons in the classroom. Future research that uses larger population sizes may require multiple teachers to be involved. Multiple teachers could change the way lessons are taught, supports are used, and Spanish is added. In this study, the researcher was able to control all of these aspects. Since the researcher only taught science in the classes, future research could use the classroom teacher instead, which would eliminate the novelty of a new teacher entering the classroom. While the new teacher eventually becomes familiar, pretest scores may differ from those of a normal classroom teacher teaching the lessons because in this study the students were in a new situation with a new teacher. In addition, this research only spanned a period of two months, but the effects were already seen in the retention of the experimental class. Future research may have other findings if the lessons with Spanish supports spanned a year instead of only two months.

Chapter 6

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Appendix A
Lesson Plan 1: Introduction to Weather and Atmospheric Pressure

Number in Sequence: 1

Author: Kelsey Conklin

Grade: 3rd

Length: 1 hour

Standards:

Next Generation Science Standards (NGSS):

3-ESS2-1: Represent Data in table and graphical displays to describe typical weather conditions expected during a particular season [Examples of data could include average temperature, precipitation, and wind direction]

CCSS ELA

3.L.6: Acquire and use accurately grade-appropriate conversational, general academic, and domain-specific words and phrases, including those that signal spatial and temporal relationships.

3.SL.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.

WiDA

ELD Standard 4: The Language of Science: Depending on level of student, students will be able to state reasons for or explain different outcomes for events based on realia, sentence starters, and teacher guidance, with varying amounts of detail.

Content Objective: Students will understand weather and be able to explain one of its main elements, atmospheric pressure as well as list the instrument used to measure it.

Language Objective: Students will be able to use and understand the terms atmospheric pressure and barometer, but will also be able to use simpler terms for them and connect the different tiered words.

Table 1: Standards & Vocabulary Lesson Scaffolding Planning Chart

| BICS (Tier 1) Engagement & Exploration | BICS / CALP (Tier 2) Engagement & Exploration | CALP (Tier 3) Explanation, Elaboration & Evaluation | Definition |
|---------------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Outside | Weather | Weather | The state of the layer of air that surrounds Earth at a given time in a particular place. Temperature, humidity (precipitation and cloud cover), air pressure, and wind speed all contribute to weather. Estado de la atmósfera en un periodo y en |
| A fuera | El tiempo | El tiempo | |

| | | | |
|------------------------------------------|--------------------------------------------------------|----------------------------------------|-------------------------------------------------------------|
| | | | un lugar determinado. |
| Heavy Air | Air Pressure | Atmospheric/Barometric Pressure | The weight of the Earth's atmosphere over an area. |
| El Aire Pesado | La Presión del Aire | La Presión Atmosférica | El peso por unidad de superficie ejercida por la atmósfera. |
| Tool to measure air | Instrument to measure air pressure | Barometer | An instrument that measures air pressure. |
| Una herramienta que mide el aire. | Un instrumento que mide la presión atmosférica. | El Barómetro | Un instrumento que mide la presión atmosférica. |

Materials:

Engagement

Sounds of storms (thunder, rain, wind..)

Pictures of severe weather (lightning, hurricanes, tornados...) See attached

Explanation

Plain paper to write weather definition

Vocabulary strips with the words weather, humidity, atmospheric pressure, wind speed, and temperature written on them

Elaboration

Straw

Small coffee can

Plastic wrap

Scissors

Index card

Rubber band

Tape

Evaluation

Large data collection chart, partially filled in

Weather Station

Safety Measures Required: Students will be making the noises of a storm in class, however it is important that everyone knows and follows the quiet signal in case there is an emergency or some other reason we need to suddenly be quiet. In addition, the lights will be turned on and off a few times. It is important for students to stay in their seats during this time so that nobody trips and hurts themselves.

Unit Fit and Lesson Rationale: This lesson is an introductory lesson to weather, it will be the first in a succession of lessons. The following lessons will all deal with parts of weather, therefore this lesson introduces students to the specific parts, builds background knowledge, and assesses students for prior knowledge. In addition, students will start to look at specific

characteristics of weather with respect to air pressure. Finally, students will start collecting air pressure data to be used later in the unit. Since the class is studying some of these topics outside of these lessons as well, this lesson serves to discover what is known and what isn't yet. The lesson is a modified 5E instructional plan. Although it contains all of the parts, it contains two slightly different topics within one lesson period.

Teacher Content Background Knowledge:

Weather background knowledge from Teacher Background: Patterns of Change: Weather.

“Since ancient times, people have tried to identify patterns of change that could help predict the weather. People have looked to the sky, to animal behaviors, and to plant growth for signs of rain or snow, or to unusually cold winters or hot summers for when to plant a garden.

Seasonal weather patterns are fairly dramatic for much of the United States. Winters tend to be cold, with snow and ice while summers are very warm or hot. Plants start blooming in the spring, change to green in the summer, change to brown (or other colors) in the fall, and finally, they become dormant (many without leaves) in the winter. In some areas, the rainfall increases during certain seasons. In other areas, tornadoes or hurricanes are more likely during certain seasons.

When we say weather, we are talking about things taking place in the Earth's atmosphere over the short term, such as hours or days. Most of our weather is directed by the sun. Areas close to the equator receive more energy from the sun than those closer to the Earth's poles and within those areas, the various surfaces (such as oceans, forests, deserts, etc.) have different abilities to soak up the sun's rays. The resulting temperatures have the biggest effect on the Earth's weather. The tilt of the Earth (which leads to the different seasons) also affects the amount of direct sunlight a specific area receives, leading to even more temperature differences.

These temperature differences affect the atmospheric (or air) pressure around us. When air is heated, it expands, which lowers the air pressure. The reverse is also true. Differences in air pressure can cause all types of weather. For example, air naturally moves from areas of high pressure to areas of low pressure, and this movement causes wind. Also, different air pressures are associated with different types of weather. Some common forms of weather on Earth include wind, clouds, rain and snow. More extreme weather, such as blizzards, tornadoes and hurricanes, occur much less frequently.”

Air Pressure background from Learning Lesson: Measure the Pressure II - The "Dry" Barometer.

“Air is a substance that takes up space, and moves as wind. It also causes pressure that is sometimes higher and sometimes lower. Air pressure is the weight of air in our atmosphere pressing down upon the earth. It can be compared to the weight of water pressing down on a person as they dive deep into a pool of water. People can feel the effect of air pressure on their ears as they hike up and down a large mountain. There is a huge amount of air above us that goes up as high as 100 miles. With all that air on top of us, it is like being at the bottom of the deep end of the swimming pool. But instead we are at the bottom of an ocean of air. Just like there is pressure at the bottom of a swimming pool, there is pressure caused by the weight of the air on all objects (including humans) on and above Earth's surface. At sea level there are about 15 pounds of air pressure per square inch. The instrument that measures the air pressure is called a barometer. A barometer helps us notice if there is a change in the air pressure. Watching it

closely from day to day predicts what the weather will be like in the next day or two. If the needle of the barometer is 30 or higher, it means that we will have fair weather for a while with increasing temperature. If the needle of the barometer drops below 30, this means there will be a change soon in the weather that could cause wind, clouds, and/or precipitation. Low pressure always precedes a change in the weather.

Barometers using mercury are heavy and fragile. The idea of a "dry" barometer was conceived by Gottfried Wilhelm Leibniz around 1700. The idea was to detect pressure changes using sealed bellows. The first working version of an aneroid (without water) barometer was built in 1843 by French scientist Lucien Vidie. This made the barometer very portable and it became a commonly used meteorological instrument. It was still calibrated to the mercurial barometer with readings in inches of mercury. Even as late as the 1990s, National Weather Service offices still calibrated and verified the accuracy of the aneroid barometer with the mercurial barometer. This activity has students constructing a barometer similar to an aneroid barometer. It is the most common type of barometer for home use. The aneroid cell volume is very sensitive to changes in atmospheric pressure as it expands and contracts as air pressure decreases or increases. Attached to the aneroid cell is a lever indicating the air pressure. In this case, the aneroid cell is the coffee can. In this barometer, high pressure in the atmosphere will weigh more than the pressure inside the can at the time the barometer was constructed. That added weight will force the plastic wrap into the can, causing the straw tip to rise, indicating higher pressure. The opposite will occur when low pressure is in the area. The decrease in weight of air on top of the can will help cause the plastic wrap to rise, therefore lowering the straw tip. Today, even with sensitive electronic sensors having replaced the metal aneroid cells in most barometers, those electronic sensors still need to be calibrated to ensure their accuracy. For that calibration, we still use mercurial barometers" (2014)

Student Background Knowledge:

While this is an introductory lesson for this unit, students should enter third grade with some prior knowledge of weather. NGSS states that second graders should be able to use information from several sources to provide evidence that Earth events can occur quickly or slowly (2-ESS1-1). This standard not only relates to weather, but also to the idea that students are using sources to provide evidence to support something. Looking back further, in kindergarten, students should learn to ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to severe weather (K-ESS3-2). Students in kindergarten should also be able to use and share observations of local weather conditions to describe patterns over time (K-ESS2-1). In addition, students will have had some exposure to Earth Science and weather through their regular classroom lessons. While these are the topics that should have been covered in school up until this point, students have all experienced weather outside of school as well. Most likely they have been talking about the weather conditions every day in the calendar portion for at least one of their prior grades. In addition, by this point, most of them notice when they might want to wear pants or sweatshirts because the weather looks like it may not be ideal for the day. As to barometric pressure, many students have hiked up a mountain, driven over a mountain pass, flown on a plane, or jumped in the deep end of the pool. These are all examples where we can feel pressure (although they are not all air pressure).

Lesson Body:

Engagement (10 minutes): Students will listen to sounds of storms, specifically thunder and

lightning in order to activate background knowledge. After listening to the sounds, students will share with partners what they know about storms and weather. As they are discussing, teacher will hand out pictures of different types of weather to add to the discussions. Discussions could include, what are some examples of weather (good and bad)? Have you ever planned an activity that got ruined by bad weather? Is weather always the same? We will then share our ideas as a class, keeping track of the ideas on the board for later discussion. We will specifically talk about the sounds we heard and what is involved in a thunderstorm. This basic discussion over what is weather and the different types will lead us in to a storm demonstration.

Exploration (10 minutes): As a class, we will make a storm. Before starting, we will discuss all elements as well as classroom management. In order to regain order after the simulation, as soon as the light stays on permanently, we will be quiet. One student will be assigned to be in charge of lights. In order to make a storm, we will:

1. Turn off the lights to make it dark and cloudy.
2. One group will tap fingers on the desk to show it starting to rain.
3. Another group will tap fingers harder to show harder rain.
4. Flip lights on and off quickly for lightning
5. Other groups will be assigned clapping hands, snapping fingers, and stomping feet to show the storm getting worse.
6. Then we will go backwards, getting quieter in order to show the storm moving away.
7. Turn lights back on and leave them on.

After finishing our storm, we will start a discussion about the elements that will lead us into the explanation. Students should be asked to think about each of the actions we did and how they relate to a thunderstorm.

Explanation (15 minutes): We will start by answering the question students were asked to think about, how does each element we acted out relate to something in a real thunderstorm? This should include the idea that the storm doesn't usually just stay in one spot, ours got louder and quieter as it moved in and away. In order to continue the discussion, students can be asked:

1. Why are thunderstorms dangerous?
2. What can happen if you are out in a thunderstorm?
3. What are precautions that you must take in a thunderstorm?

Then, students will be asked to talk about other dangerous weather (referring back to our ideas on the board from the engagement). We will work towards a group definition of weather, asking students to consider where does weather come from and how does it happen? In addition, what does weather look like in different seasons here? Is that the same in other places? What makes one day's weather different from another day's? Important concepts to be addressed by students or teacher:

- Weather changes with the seasons.
- Weather has patterns and can be predicted sometimes.
- There are certain big ideas of weather which are included in the definition.

Weather: The state of the layer of air that surrounds Earth at a given time in a particular place. Temperature, humidity (precipitation and cloud cover), air pressure, and wind speed all contribute to weather.

The definition that students come up with will be written on a large piece of paper to be put on

the wall. All the elements will be written on vocabulary strips and also put on the wall to be used in the later lessons.

After solidifying a definition for weather, we will talk about some of the parts and make sure they are introduced (at least in lower levels of vocabulary, like hot/cold, rain, and wind), as well as discuss that they can all be measured. We will be covering them all in later lessons, so air pressure is the only one that needs to be clearly defined today.

Ask students what happens when they swim really deep in a pool, hike really high on a mountain, or fly in a plane. Do they feel pressure in their head? It is kind of like someone pushing on their brain right? What do they think is pushing? It is actually air (in the pool it is water, but it feels similar). This is called air pressure, which is also known as atmospheric or barometric pressure. Just like there are other instruments to measure other things, explain to students that there is an instrument called a barometer that measures air pressure and we will be making one today. In addition, we will start measuring different parts of the weather over the next few weeks.

Elaboration(10 minutes): From TRB 4:2 - Investigation 4 - Air Pressure & Barometers (2004). Students will have a chance to elaborate on their knowledge of weather, specifically atmospheric pressure by making a barometer. We will be making it as a class, but everybody will get to check it over the next few weeks.

1. Cover the top of the coffee can tightly with the plastic wrap, using the rubber band to hold it in place. (The cover should be a taut, airtight fit.)
2. Position the straw so that it lays across two thirds of the cover with the remaining length of the straw suspended over air. Tape in place.
3. At a 90° angle, fold one short end of the index card at about one inch from that end. Tape the folded end of the index card to the can behind the straw in such a way that allows you to make marks on the card every day.
4. Record the level of the straw onto the card.

After the barometer is completed, have all students gather around and ask for ideas about how they think it might work (based off of our earlier discussion about pressure). Make sure students see an example of how the plastic wrap can be pushed to show pressure against it. When there is high pressure in the atmosphere, it will weigh a lot and push against the plastic wrap, forcing it inside and raising the straw tip. However, when there is low pressure in the atmosphere, the pressure in the can will push against the plastic wrap, making it bubble, and lowering the straw tip. One seating group who seems to understand really well will be in charge of the classroom barometer and writing if it is a high or low pressure day on the classroom chart.

Evaluation(10 minutes): Concepts will be formally tested in the later test over the whole unit, however students will show knowledge of measuring different weather aspects throughout the unit by keeping track of weather. A classroom chart will be introduced at the end of the lesson, while actually larger, it will look like this after this lesson, as the lessons go on, more categories will be introduced:

| | | | | | | |
|-------------------------|----------------------------------|--|--|--|--|--|
| Date | High or low atmospheric pressure | | | | | |
| How do we measure this? | Write high or low | | | | | |

While specific groups are going to be in charge of each forecast, any student can go check the instruments and test their knowledge of the concept. Explain that it is important that we measure this at the same time every day because it can change throughout the day. The weather station will also be introduced now. The group in charge of the barometer will look at the barometer, but also check the weather station and write down their findings.

Clean Up (5 minutes): We will place our barometer in an out of the way spot that is easy to check every day.

Closure: Today we learned about some of the different parts that make up weather and how they might change throughout the year. One of these parts is air pressure which can be measured by a barometer.

Adaptations, Accommodations and Modifications:

Many students have experienced weather, which provides for background experience to help learning. Both the sounds of storms and the storm created together will provide shared background experiences and conversation topics that can be discussed among the class. In addition, neither the engagement nor exploration are language heavy (let alone content language), therefore, all students can actively participate. Content vocabulary is written on strips in order to place on wall for the rest of the lessons. Definition of weather is group made in order to help with retention and create a sense of ownership. Different opportunities for talking with other students, in groups, and with the teacher throughout the lesson. Group work where students can be grouped with similar language levels, buddies to help with language, or varying degrees of language levels in order for everyone to learn from everyone. Modeling will be used with all instructions given and realia (like pictures) will also be included.

Extreme Weather Information, from Extreme Weather on Our Planet



- **Tsunami** (pronounced soo-nahm-ee) is a series of giant waves after underwater movement due to a variety of natural events such as landslides earthquakes, volcanic eruptions, and meteorites. The waves travel in all directions from the area of disturbance, much like the ripples that happen after throwing a rock. The waves may travel in the open sea as fast as 450 miles per hour. As the big waves approach shallow waters on the coast, they grow large and smash into the shore. They can be as high as 100 feet and can cause a lot of destruction on the shore. "Tsunami" is a Japanese word. Tsu means "harbor" and nami means "wave."
- **Flooding** is a type of extreme weather. Flooding happens when there is heavy rainfall in a short amount of time and water overflows its natural or artificial banks onto land that is usually dry.
- **Tornadoes** are a type of extreme weather. They are vertical funnels of rapidly spinning air. Tornadoes include clouds, strong wind, rain, and sometimes hail. They move at speeds of about 16 to 32 kilometers per hour (10 to 20 miles per hour), and their winds can top 402 kilometers per hour (250 miles per hour). They come in all shapes and sizes. Born in the roiling entrails of storms, the most dangerous ones can pack winds over 300 miles (480 kilometers) an hour—enough to lift houses off foundations and toss cars into the air.
- **A thunderstorm** is a storm with lightning and thunder. It is produced by a cumulonimbus cloud, usually producing gusty winds, heavy rain and sometimes hail.
- **Hurricanes** are severe tropical storms that form in the southern Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and in the eastern Pacific Ocean. They gather heat and energy through contact with warm ocean waters. Evaporation from the seawater increases their power. Hurricanes rotate in a counter-clockwise direction around an "eye." Hurricanes have winds of at least 74 miles per hour. When hurricanes come onto land, their heavy rain, strong winds, and large waves can damage buildings, trees, and cars.

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Appendix B

Lesson Plan 2: Temperature

Number in Sequence: 2

Author: Kelsey Conklin

Grade: 3rd

Length: 1 Hour

Standards:

Next Generation Science Standards (NGSS):

3-ESS2-1: Represent Data in table and graphical displays to describe typical weather conditions expected during a particular season [Examples of data could include average temperature, precipitation, and wind direction]

CCSS Math

3-MD-4: Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units – whole number, halves, or quarters.

CCSS ELA

3.L.6: Acquire and use accurately grade-appropriate conversational, general academic, and domain-specific words and phrases, including those that signal spatial and temporal relationships.

3.SL.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.

WiDA

ELD Standard 4: The Language of Science: Depending on level of student, students will be able to state reasons for or explain outcomes for certain events based on realia, sentence starters, and teacher guidance, with varying amounts of detail.

Content Objective: Students will be able to discuss temperature and how it relates to weather as well as how it can be measured and how thermometers work.

Language Objective: Students will be able to fluently use the words temperature, thermometer, and degree, as well as understand how they all relate to each other.

Table 2: Standards & Vocabulary Lesson Scaffolding Planning Chart

| BICS (Tier 1) Engagement & Exploration | BICS / CALP (Tier 2) Engagement & Exploration | CALP (Tier 3) Explanation, Elaboration & Evaluation | Definition |
|-------------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------|------------------------------------------------------------|
| Hot or cold | Temperature | Temperature | The degree of hotness or coldness of a body or environment |

| | | | |
|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------|
| Frío o caliente | La temperatura | La temperatura | Magnitud física que mide la sensación subjetiva de calor o frío de los cuerpos o del ambiente. |
| | Unit for temperature Unidad de medida de la temperatura | Degree El Grado | A unit to measure temperature Unidad de medida de la temperatura |
| Tool to tell how hot or cold it is La herramienta que medir el calor o el Frío. | Instrument to measure heat or cold Instrumento que sirve para medir el calor o el Frío. | Thermometer El Termómetro | An instrument to measure temperature Instrumento que sirve para medir la temperatura. |

Materials:

Engagement

- Thermometer for each group
- Sandwich Zip-lock baggie with ice in it for each group

Exploration

- Thermometer for each group
- Recording sheet for each student (attached)
- Pencil for each group

Explanation

- Vocab strips with temperature, thermometer, and degree written on them

Elaboration

- Clear, narrow-necked plastic bottle (~355 ml [12 oz] water bottles work well) (Ask students to bring rinsed plastic bottles from home) (one for each group)
- Clear, long, plastic drinking straw (one for each group)
- Worksheet (same as earlier, attached) (for everyone)
- Measuring cups
- Premixed 207 ml (7 oz) rubbing alcohol and 207 ml (7 oz) water in a bottle (need 2oz mixture for each group) with food coloring
- Rulers
- Fine-point permanent markers
- Modeling clay
- Tub of warm water and cold water

Safety Measures Required:

Students should not drink or even taste the rubbing alcohol or the alcohol-water mixture. Students should also make sure to wash their hands after completing the activities.

Unit Fit and Lesson Rationale: This lesson continues our in depth study of the different elements of weather. Students were introduced to weather and its elements in the last lesson.

They looked more deeply into atmospheric pressure, which is one of the contributing factors to weather and is related to temperature. Both of these concepts contribute to cloud formation and wind, which are some of our next lessons. Students will continue to collect weather data in this lesson. The lesson is formatted as a 5E lesson plan in order to facilitate student discovery and connection to background knowledge.

Teacher Content Background Knowledge:

According to Hislop and Edwards, “Atmospheric temperature can be affected by sunlight, wind, latitude, altitude, and the land surface. Temperature can also be affected by surface reflections. Heat is a form of energy caused by the internal motion of molecules. The slower the molecules are moving, the less heat is present. Temperature is a measure of heat energy in a substance. It can be measured by a thermometer” (2002).

“A thermometer is a delicate instrument used for measuring temperature. It needs to be handled carefully so that it doesn't break. The liquid (either red-dyed alcohol or mercury) inside the glass tube expands as it is heated and rises in degrees Fahrenheit or Celsius that can be read on the scale. Soil generally absorbs heat from the sun faster than water, so it is usually warmer. Shiny or light-colored surfaces reflect more of the sun's energy than dark colors, so they are cooler. Heat rises in a room, so temperatures taken at the ceiling level are generally warmer than at floor level. When a thermometer touches another object, heat is transferred from the warmer object to the cooler object until their temperatures are equal. *Heat transfer* between touching objects is called *conduction*. Thermal energy always transfers from warmer bodies to cooler bodies until they are at the same temperature. If the thermometer gains thermal energy from its surroundings, the liquid in the thermometer expands. The liquid contracts if the thermometer loses thermal energy to its surroundings.

A thermometer scale is based on the freezing and boiling temperatures of water. In the Celsius scale, water freezes at 0 degrees and boils at 100 degrees. In the Fahrenheit scale, water freezes at 32 degrees and boils at 212 degrees. Degrees in the Celsius scale are larger than in the Fahrenheit scale” (TRB 4:2 - Investigation 2 – Thermometers, 2004).

Student Background Knowledge: Students have now been introduced to weather and its elements. Therefore, they have already learned about atmospheric pressure and will now be introduced to temperature (with relation to weather). However, up to this point, students have prior knowledge of weather from earlier grades. Looking back to kindergarten, students should learn to ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to severe weather (K-ESS3-2). Students in kindergarten should also be able to use and share observations of local weather conditions to describe patterns over time (K-ESS2-1). Relating specifically to temperature, students notice when it is hot or cold outside. Many of them can tell when they need to wear a sweatshirt or not. While not all may understand thermometers, many are at least familiar with them, especially if they have ever had their temperature taken.

Lesson Body:

Engagement (10 minutes): Students will work with their shoulder partner. Each group will receive a thermometer and a baggie full of ice. After a brief discussion to make sure that each group has somebody with a little bit of knowledge about thermometers, students will be challenged to see if they can make the temperature rise or fall without leaving their seats. They

should all see how high or low they can make the temperature go. (Remind students not to stick the thermometer in their mouths). Teacher will circulate classroom, offering helpful hints or background knowledge about thermometers as needed. This will help provide the information needed for students to proceed with the exploration as well as provide an opportunity for the teacher to assess students' prior knowledge about thermometers. Key points to question students about for understanding as they are working:

- How the temperature scale works and which numbers are large and small?
- Which numbers mean hot and which numbers mean cold?
- What part needs to be connected with the area needing to be measured?
- Are thermometers fragile?

(TRB 4:2 - Investigation 2 – Thermometers, 2004).

Exploration (15 minutes): If groups are working well together, the groups will stay the same (if not, some students will be rearranged in order to create the safest atmosphere in which to use the thermometers). Partners will be number one and two. After discussing safety with the thermometers (and explaining that we don't want them to break), recording worksheets will be passed out. We will look over the recording worksheet to make sure it makes sense and then we will all go outside. The area we are working in will be shown and groups will be allowed to find places to measure. Number one will start by picking one place to measure. While both students will look at thermometer and work together to determine the temperature, number one will make the final decision for both students to record the location and temperature on their recording sheets. Then number two will repeat the process. All groups will be asked to be ready to share their data.

Explanation (10 minutes): When we return to the classroom, groups will be asked to share the highest temperature they found and its location, as well as the lowest temperature. We will look at any similarities between low and high temperature places (for instance, different materials hold heat better, use the idea of how hot the black top is hotter on summer days than the grass). Since we have been using temperature, what does it mean? (How hot or cold something is) How do we measure it? (With a thermometer) Draw a large thermometer shape on the board and ask students to share what they know about it (for instance, when have they used it, what do any parts mean...?) Add notes to the board as students discuss the thermometer, making sure to point out:

- There is liquid in the thermometer
- Thermometers are broken into equal units of measure called degrees
- When it is hotter, the liquid in a thermometer goes up because the liquid gets bigger
- When it is cold, the liquid in a thermometer goes down because cold makes the liquid get smaller.

Discussion should also include how temperature relates to weather. Question students, when do we usually have hot temperatures and what kind of weather goes with them? What about cold temperatures? Does anybody know what happens when cold and hot temperatures meet each other? Do you think they would “get along” well? Do opposite things usually mix very well? When these kind of temperatures meet each other, they clash. Just like other things that don't mix well, these don't and they create a weather, sometimes a thunderstorm and sometimes just

rain.

Elaboration (15 minutes): Working in their seating groups, students will make a thermometer. Students will use small necked, plastic disposable bottles. The colored mixture of rubbing alcohol and water will be premixed (and constantly stirred in order to stay mixed). After talking about the materials that we are going to use (for instance, do not drink or taste the mixture) students will follow along with the class demonstration. They will be number off 1-4.

1. Number 1 will place the bottle flat on the table and use the marker to make a light mark on the bottle, a thumb's width up from the bottom.
2. Teachers will come around and pour about $\frac{1}{4}$ of a cup of the mixture into the bottles (up to the line).
3. Numbers 2 and 3 will use the marker and ruler to mark off equally spaced marks on the straw (students can use any division, however they need to be equal and not too large). Make sure not to bend the straw.
4. Remind students to look at the thermometer example on the board and ask them to decide how they want to mark their thermometer, number 4 gets to mark the numbers off.
5. As a group, let students decide what their unit of measure should be (real thermometers are degrees, but theirs are different amounts, so should be something different, school mascot? Animal?) In real life we use Celsius, Fahrenheit or Kelvin.
6. Number 1 should place the straw in the bottle and hold it at the neck of the bottle without letting it touch the bottom.
7. Number 2 should use modeling clay to seal the neck of the bottle so the straw stays in place, but must not cover the straw opening. There must be a really good seal between the straw and the top of the bottle. The finished thermometer should look similar to the Figure 1 diagram.
8. Have all of the students wrap their hands around the bottle and observe what happens to the mixture in the bottle. For more dramatic results, place the thermometer in a tub of warm water and cold water.



(Duren, Lyng, Zarske, & Carlson 2005)

Evaluation (10 minutes): Concepts will be formally tested in the later test over the whole unit, however discussion will provide teacher with formative assessment. Regroup students and have them share some of their results. When they placed all of their hands on the bottle, did the liquid (and therefore temperature) go up or down? What about in the ice bath? What is happening (using what we learned from earlier)? What would happen if you placed your thermometers in a really hot situation? Refocus on the recording sheet that we started in the last lesson. Talk a little about how barometer readings are going, has there been any trouble? Remind everyone how to read the barometer and pick a new group to record barometer readings. Remind everyone where the weather station is and how to read it, now look for temperature and air pressure. Remind students that it is important to record it at the same time every day.

| | | | | | | |
|-------------------------|----------------------------------|-----------------------------------|--|--|--|--|
| Date | High or low atmospheric pressure | Temperature recorded for the day. | | | | |
| How do we measure this? | Write high or low | Write number | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Clean Up: Students will place thermometers and worksheets on the back table in order for teachers to collect and dispose of.

Closure: Today we learned that another element of weather is temperature and it can be measured by a thermometer.

Adaptations, Accommodations and Modifications:

Students have already had shared experiences coming into this lesson from the last lesson. In addition, the last lesson started to introduce some elements of weather, so students have had prior introductions to the content. In addition, many of the activities in this lesson are hands-on and can be completely modeled in order to supplement language acquisition or help any non-verbal learners. All academic language is tiered and placed on vocab strips on the wall. The large picture of the thermometer will be used as a scaffold to explain all of the parts of the smaller thermometers, as well as provide a guide to look back to. Many opportunities for student input in order to explain things in their own way.

Temperature Worksheet

Pick somewhere to measure the temperature with your thermometer.

| | Location | Temperature |
|-----------------|----------|-------------|
| Number 1 | | |
| Number 2 | | |

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Appendix C

Lesson Plan 3: Wind Direction

Number in Sequence: 3

Author: Kelsey Conklin

Grade: 3rd

Length: 1 Hour

Standards:

Next Generation Science Standards (NGSS):

Earth Science:

3-ESS2-1: Represent Data in table and graphical displays to describe typical weather conditions expected during a particular season [Examples of data could include average temperature, precipitation, and wind direction]

CCSS Math

3-MD-1: Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects

CCSS ELA

3.L.6: Acquire and use accurately grade-appropriate conversational, general academic, and domain-specific words and phrases, including those that signal spatial and temporal relationships.

3.SL.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher- led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.

WiDA

ELD Standard 4: The Language of Science: Depending on level of student, students will be able to state reasons for or explain outcomes for certain events based on realia, sentence starters, and teacher guidance, with varying amounts of detail.

Content Objective: Students will be able to discuss wind and talk about why it is important to be able to measure it as well as talk about what places are windier.

Language Objective: Students will understand the term wind and how it relates to anemometer.

Table 3: Standards & Vocabulary Lesson Scaffolding Planning Chart

| BICS (Tier 1) Engagement & Exploration | BICS / CALP (Tier 2) Engagement & Exploration | CALP (Tier 3) Explanation, Elaboration & Evaluation | Definition |
|---------------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| | Air movement | Wind | The movement of air, which tends to move from a high pressure area to a low pressure area. |

| | | | |
|--------------------------------------------|-----------------------------------------|----------------------------------------|----------------------------------------------------------------------------------------------------------|
| | El movimiento del aire | El Viento | Corriente de aire producida en la atmósfera por el encuentro de diferentes presiones en áreas distintas. |
| Heavy Air | Air Pressure | Atmospheric/Barometric Pressure | The weight of the Earth's atmosphere over an area. |
| El Aire Pesado | La Presión del Aire | La Presión Atmosférica | El peso por unidad de superficie ejercida por la atmósfera. |
| Tool to measure wind | Instrument to measure wind | Anemometer | An instrument that measures wind speed and strength. |
| Una herramienta que mide el viento. | Instrumento para medir el viento | El anemómetro | Instrumento para medir la velocidad o la fuerza del viento |

Materials:

Engagement

- Four foot length of crepe paper for each student
- Fans if there is no wind

Exploration

- Straws
- Small hole punch
- 1 brad per student
- 2 washers per student
- Scissors
- Pinwheel template for each student (attached) (printed on colored paper)
- Fans if there is no wind
- Commercially made pinwheels in case homemade ones don't work

Explanation

- Windmill Pictures
- Anemometer or picture of anemometer
- Vocab strips with wind and anemometer written

Elaboration (students will be in teams of three)

- 4 small paper cups
- Small sewing pin
- Sharpened pencil with eraser on the end
- Stiff, corrugated cardboard (enough to cut two, same-size strips, each 13 to 23 cm [5 to 9 in] long for each team; used boxes are ideal)
- Modeling clay (about 85 grams or 3 oz or ¼ cup)
- Scissors
- Marking pens
- Rulers (for measuring)
- Stapler

Safety Measures Required: Remind students that pins are sharp, and they should *only* press their pins into their anemometer (not into the furniture or, especially, into each other!). Teachers will be doing most of the work with the pins, however, students should be reminded not to take the pins out of the erasers after we put them in.

Unit Fit and Lesson Rationale: In the last lesson, students learned about how temperature contributes to weather and now they will learn about how wind is an element of weather. All of these elements will be used in the final two lessons when students predict the weather and compare weather to climate. The next lesson will be on clouds, precipitation, and humidity. Wind contributes to all of these elements, so it is important to introduce it before that lesson. The lesson contains many hands-on activities and is structured as a 5E lesson in order to facilitate student discovery.

Teacher Content Background Knowledge: Wind is one of the elements of weather. It is the movement of air that can be felt against our face and body. We can see the effect of wind by the movement of objects. The direction, temperature, and speed of wind can help us predict changes in the weather. According to Todd, Straten, Zarske, and Yowell, “Winds can be created by local differences in air pressure and temperature, as well as surface disruptions, such as mountains, cliffs and trees. On hot summer days, many people go to the beach to enjoy the cool breezes, which are usually *sea breezes*. Sea breezes form when the land mass heats up faster than the ocean during the day so that hot air rises over the land. This in turn creates a low pressure that draws cool air in from the sea, resulting in the pleasant breeze you feel as you walk along the shore. During the night, the opposite happens and *land breezes* are formed. These breezes are less strong because the temperature and pressure difference are less. *Monsoons* are similar to land and sea breezes, but they occur over a large scale and change from season to season, rather than day to night. During the summer months in southern Asia, monsoon winds blows from the Indian Ocean and the South China Sea to the land. These monsoons are often accompanied with tremendous rains. During the winter, the wind direction switches and blows from the land to the sea. These winter winds are dry, resulting in clear weather for Southern Asia” (2004).

“How can we tell the difference between a windy day and a really windy day? We measure the speed of the wind. How do we measure wind speed? We use a special instrument called an *anemometer*. Wind speeds are usually measured using a *cup anemometer*. A cup anemometer has a vertical pole with three cups that capture the wind. The number of times the cups spin around per minute is counted electronically” (Zamora-Thompson, Duren, Mach, Zarske, & Carlson, 2005).

Student Background Knowledge: Students have now studied weather in general, as well as had an introduction to several elements. They have studied air pressure and temperature more in depth within this unit. Even before third grade, students should have looked at wind in second grade with standard 2-ESS2-1, compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. In addition they should have had some exposure to wind in kindergarten. Use and share observations of local weather conditions to describe patterns over time (K-ESS2-1). Finally, we live in Nevada, therefore students have most likely been exposed to wind for a high percentage of their year. By experimentation and playing, most

students know that sometimes the wind blows in their face or against them, and sometimes it blows more than other instances.

*****This lesson is dependent on windy weather. If the weather is not cooperating, we will either swap lessons around so that it is a windy day, or we will use the fans in order to simulate wind. ******

Lesson Body:

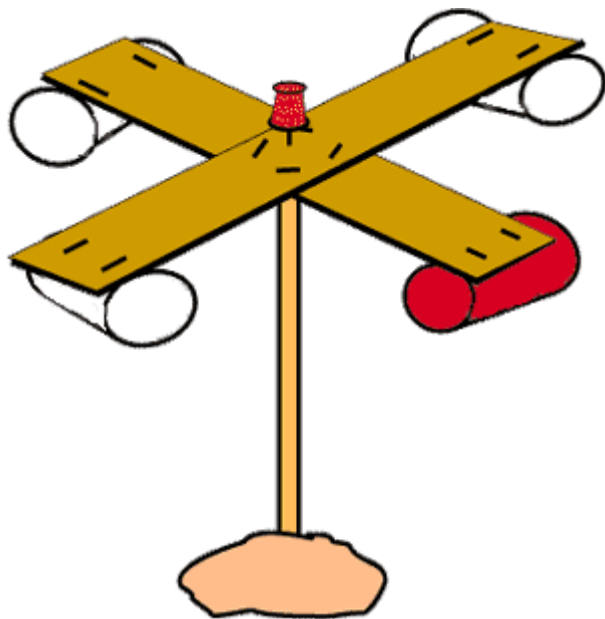
Engagement(10 minutes): Since we do live in a windy climate, many students are familiar with wind, but not necessarily any of the information behind it. In order to activate background knowledge, we will start by going outside (if it is windy). If it isn't we will use fans inside. Students will have a four foot length of crepe paper and they will see what way it blows when they move it around (up, down, back, and forth). Students will be encouraged to run with and against the wind in order to see what happens with the crepe paper. Next, students will wet one finger and hold it up in the air, what do they feel? Finally, we will collect the streamers and return inside.

Exploration(10 minutes): To see how wind can affect other objects, students will each make a pinwheel (Todd, Straten, Zarske, and Yowell, 2004),

- 1.) Materials will all be passed out to students
- 2.) Instructions will be modeled for students, with teacher circulating to help.
- 3.) First, have students cut the bottom half off of the paper, following the line.
- 4.) Then have them cut along the dotted lines (don't cut past the dotted lines)
- 5.) Demonstrate how to fold all of the corners in towards the center while teachers come around and help to use the brad to hold all of the edges to the center and into the straw, placing a washer in between the paper and the straw and the brad and the paper.
- 6.) Students can now try blowing on their pinwheels in order to make them spin, does it work?
- 7.) If windy, we will go outside, otherwise we will use fans inside.
- 8.) Have students turn their pinwheels into the wind (or fan) and away from it, do they spin better when they are faced a certain way? Make sure students hold their pinwheels up in the air and close to the ground as well.
- 9.) Return inside, thinking about which way the pinwheel turned best.

Explanation(10 minutes): After returning inside, students will share their discoveries about which way their pinwheels turned best. Students will be asked if they have seen pinwheels or other things like pinwheels before. Windmill pictures will be shown and students will be asked if they know what they are. How are windmills and pinwheels similar? (Both turn in the wind) But what is wind? Wind is an element of weather, what other elements of weather have we seen? (Temperature and air pressure) These elements actually contribute to wind. Technically, it is the movement of air (which we can usually feel). Usually it moves from high pressure to low pressure areas (remember our barometer?) Put vocab strips up on wall. So, wind turns both pinwheels and windmills, but how are they different? (Windmills are connected to generators, and by the wind turning them, they actually store energy that can be used by us, so we call it wind energy). However, in order for windmills to collect as much energy as possible, they need to catch as much wind as possible, when was your pinwheel catching the most wind possible?

Where? Ask them where they think the wind is the strongest. (Answer: low to the ground or high up?) Ask the students in what direction they should point their pinwheel. (Answer: into the wind, at an angle to the wind or away from the wind?) How fast could you say it was spinning? (not able to measure, just say, really really fast) Well, next, we are going to make a way to measure the wind. Remember how we measured air pressure? What did we use? Barometer. What about temperature? Thermometer. Now we will use an anemometer. Put up vocab strip. This will measure wind speed. Show actual anemometer and explain how it works, but we are going to make our own. By telling which way the wind is blowing and the speed that it is blowing at, we can predict changes in the weather.



Elaboration(20 minutes):

- 1.) Students will be broken up into teams of three in order to each make their own anemometer.
- 2.) Have students talk about where their pinwheels spun the most earlier and decide where they want to take their finished anemometers.
- 3.) While one student colors the outside of one cup, the other two students should cut the corrugated boxes into two, same-size strips, each 13 to 23 cm (5 to 9 in) long. Use the rulers, as necessary. These will be the anemometer blades.
- 4.) Demonstrate how students should then cross the cardboard strips so they make a plus (+) sign. Staple them together in the middle, where they cross), making sure the anemometer blades are of equal length. Use the rulers to measure the blades and locate the exact center.
- 5.) Next, students should staple one cup, turned sideways, to the end of each cardboard blade, making sure the cups all face the same direction.
- 6.) Teachers will come around and push a pin through center of the cardboard cross and attach it to the eraser point of the pencil.
- 7.) Students should blow on the cups to make sure the cardboard can spin.
- 8.) Remind teams that they have already picked a place to set up their anemometers and go outside to test.
- 9.) Each team should place their modeling clay on a stable surface and then stick their pencil into the modeling clay, so that the anemometer stands straight.
- 10.) Students can measure the wind speed by seeing how many times the anemometer spins around in a minute. It is easier if students watch the colored cup.

(Zamora-Thompson, Duren, Mach, Zarske, & Carlson, 2005).

Evaluation(10 minutes): Once we return to the classroom, formative assessment will occur through a discussion. Students will share the place they measured and what their rotational speed was. As a class, we will decide what the windiest place on the playground is. During the elaboration, we talked about the fact that really windy places are better for windmills, what

would be the best place for a windmill based on the fact of windiest place? Think about the anemometer, the pinwheel from earlier, and the pictures of windmills, what do they all have in common? (the individual legs). Why is it important for us to measure wind speed? Why would you want to know the wind speed? (Possible answers: To know how to dress for the weather. To determine if it is a good day to play tennis outside. To decide if it is a good day to have a picnic, read outside, or fly a kite.) Concepts will be formally tested in the later test over the whole unit. Discuss the results on the group weather sheet and ask students what they think will be added today? Check for any confusion on previous measurements.

| Date | High or low atmospheric pressure | Temperature recorded for the day. | Wind speed | | | |
|-------------------------|----------------------------------|-----------------------------------|------------|--|--|--|
| How do we measure this? | Write high or low | Write the number | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

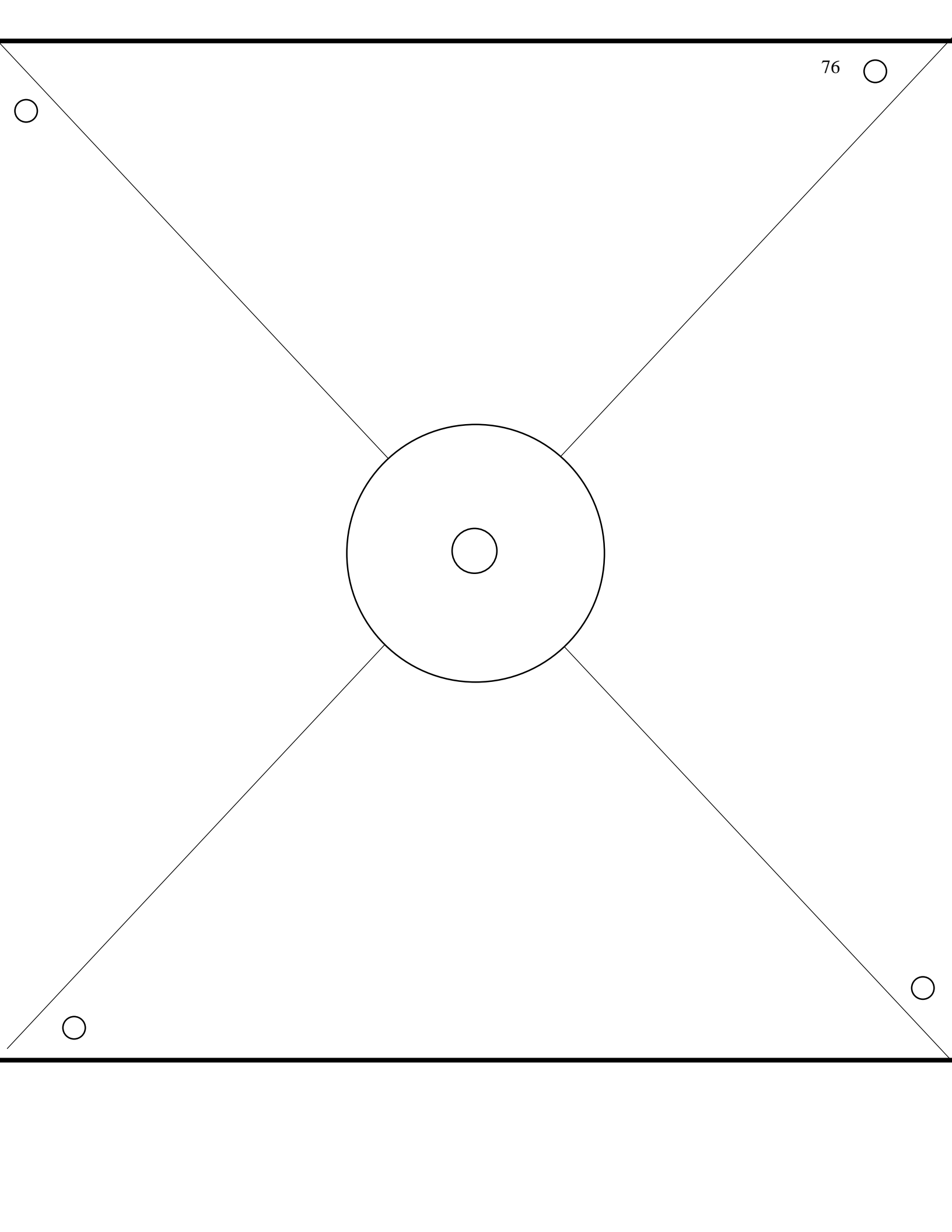
Clean Up: Students will return all materials to the teacher after the engagement. After the exploration, students will put pinwheels in their backpacks or cubbies in order to take home. Other materials will be left on tables for elaboration, however, they will be put in a pile in the center of the table out of the way. Student anemometers will be placed on the back table for teacher to dispose of, while all other materials will be placed in the collection bag at the back of the classroom.

Closure: Today we learned about wind, and what instruments can be used to show it, as well as how to measure it.

Adaptations, Accommodations and Modifications:

Due to prior lessons, all students have previous shared experiences. In addition, all students will share the experience of the engagement, which will be modeled as well as verbally explained. All activities are hands-on, with the learner involved completely. Vocabulary strips are used and realia is used when possible. Students are able to work in groups and a lot of student discussion is involved so that concepts can be presented in their own words by those that have prior knowledge.





References:

- Todd, J., Straten, M., Zarske, M. S., & Yowell, J. (2004, January 1). Lesson: Harnessing Wind. Teach Engineering: Resources for K-12. Retrieved January 4, 2014, from http://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_earth/cub_earth_lesson04.xml
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Appendix D
Lesson Plan 4: Clouds, Precipitation, and Humidity

Number in Sequence: 4

Author: Kelsey Conklin

Grade: 3rd

Length: 1 hour

Standards:

Next Generation Science Standards (NGSS):

3-ESS2-1: Represent data in table and graphical displays to describe typical weather conditions expected during a particular season [Examples of data could include average temperature, precipitation, and wind direction]

CCSS ELA

3.L.6: Acquire and use accurately grade-appropriate conversational, general academic, and domain-specific words and phrases, including those that signal spatial and temporal relationships.

3.SL.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.

WiDA

ELD Standard 4: The Language of Science: Depending on level of student, students will be able to state reasons for or explain outcomes for certain events based on realia, sentence starters, and teacher guidance, with varying amounts of detail.

Content Objective: Students will be able to recognize cloud formations and understand how clouds and precipitation are related, as well as how they both contribute to weather.

Language Objective: Students will be able to fluently use the words precipitation, humidity, and cloud, as well as understand how they all relate to each other.

Table 4: Standards & Vocabulary Lesson Scaffolding Planning Chart

| BICS (Tier 1) Engagement & Exploration | BICS / CALP (Tier 2) Engagement & Exploration | CALP (Tier 3) Explanation, Elaboration & Evaluation | Definition |
|---------------------------------------------------------------|----------------------------------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Water | Rain | Precipitation | Moisture that falls from clouds in the form of rain, snow, sleet, or hail |
| El Agua | La Lluvia | La Precipitación | El agua que se cae de las nubes en forma de la lluvia, la nieve, la cellisca o el granizo |
| Wetness | Moisture | Humidity | Dampness; the amount of water in the air. |
| Estado mojado | | La humedad | |

| | | | |
|----------------|----------------|-------------------------------------------------------------------------|----------------------------------------------------------|
| | | | Estado mojado; la cantidad de agua en el aire. |
| Cloud | Cloud | Cirrus Cloud Stratus Cloud Cumulus Cloud | a visible form of water vapor floating in the atmosphere |
| La nube | La nube | La nube cirro La nube estrato La nube cúmulo | Una forma visible de agua que está en el aire. |

Materials:

Engagement (a few of each to show)

- Large pickle jar
- Match
- Warm water
- Ice
- Flashlight

Exploration

- Cloud kit for every group-cards with pictures of the different types of clouds labeled (attached)

Explanation

- Foldable, light blue paper for each student
- Pictures of the different types of clouds to show (can use pictures from cloud kits)
- Vocab strips – clouds, humidity, precipitation

Elaboration (for each group of four)

- Half of one dry sponge
- 1 plate (plastic or aluminum)
- 1 plastic spoon
- a cup
- water (1 cup)

Safety Measures Required: To prevent slipping, minimize water dripping onto floors. Warn students that the floors may be slippery when wet and that we need to clean up any spills right away with paper towels.

Unit Fit and Lesson Rationale: This lesson continues with our unit on weather. Now that students understand temperature, barometric pressure, and wind, and how all of these elements work with each other. This lesson will introduce humidity, clouds, and precipitation. Students will continue to collect weather data in order to see how all of the elements work with each other. This lesson is in the 5E format in order to facilitate student discovery and work with students' background knowledge.

Teacher Content Background Knowledge: Just like a baker uses a recipe to bake a cake, the atmosphere must have three ingredients to make a cloud: 1) moisture (water vapor in the air) 2) temperature change, and 3) particles in the air for the water vapor to condense on. Sunlight causes water (water or ice from plants and other sources) to evaporate into the atmosphere. As

warm, moist air rises, it begins to cool and condense on dust particles (pollen, or even a drop of water or ice crystal) forming water droplets. These water droplets form clouds. They will not fall to Earth because they are too small. This lesson shows an experiment with these three ingredients in order to form a cloud in a jar. The moisture will be provided by hot water in the bottom of the jar. Some of that hot water will evaporate into water vapor so that the air inside the jar will be moist and warm. As the warm, moist air rises in the jar, it will get cooled by the ice on top. When water vapor cools, it wants to turn back into liquid, but it needs to condense onto a surface. The aerosol (or smoke from the match) will provide a surface for the water vapor to condense into tiny cloud droplets. The cloud swirls inside the jar due to the circulation of warm air rising and cold air sinking.

Earth acts just like the jar. Some of the water in the ocean evaporates into the air providing moisture. When land heats up during the day, it heats that moist air so that it will rise. (This process is called convection.) The higher up you go in the sky, the colder the air gets. Think about climbing a mountain, it's much colder up on top of it then down at the beach. The ice in the experiment represents the atmosphere cooling as the air rises. When that water vapor is cold enough to condense it has many choices of particles in the air. The aerosol (or smoke) represents small particles floating in the air (Here is a lesson on clouds, n.d.).

Real clouds take different shapes depending on the amount of water vapor available and the speed and direction of the moving air. Clouds are classified according to how they are formed. Below are the main types and their descriptions.

- Stratus clouds are low, flat, gray clouds that look like sheets covering the sky. They are layered and streaky. They are the closest clouds to the ground and form as a large moist air mass rising slowly. They form as low as surface level (fog) to about 6,500 feet above the ground. They can produce rain, drizzle, snow, or mist.
- Cumulus clouds are puffy and white-like cotton balls, but flat along the bottom. They form from 2,000 to 20,000 feet above the ground and through warm air rising quickly over a small area. They usually indicate fair weather. Sometimes they grow very large and become thunderheads. As these clouds gather they create thunder and lightning and produce precipitation in the form of rain and hail.
- Cirrus clouds are thin, curly, wispy clouds. They are sometimes referred to as mares' tails and can look like feathers. They form between 25,000 to 40,000 feet above the ground. They are so high in the atmosphere that the water droplets freeze into ice crystals. They often indicate an incoming storm or weather change. (picture)



As more and more water condenses to form these clouds, the water droplets grow. When they get too heavy to stay suspended in the cloud, even with updrafts within the cloud, they fall to Earth as rain. If the air in the cloud is below the freezing point (32 °F or 0 °C), ice crystals form; if the

air all the way down to the ground is also freezing or below, you get snow. However, if the layers of atmosphere within the cloud, and between the cloud and the ground, alternate between warmer than freezing and colder than freezing, you get other kinds of precipitation.

Clouds are important in determining how much of the Sun's energy is absorbed and trapped in the atmosphere. They are thus very important in altering the temperature of the air and Earth's surface. The warmer the air, the more water it can hold. The warmer the oceans, the faster water evaporates from them. And the more water in the air, the more the sun's energy is trapped, making things still warmer (TRB 4:2 - Investigation 1 – Clouds, 2004).

Student Background Knowledge: Students have already gone through earlier lessons on weather in general, atmospheric pressure, temperature, and wind. All of these are concepts involved in making clouds, which is discussed in this lesson. In addition, in kindergarten, students were exposed to standard K-ESS2-1, use and share observations of local weather conditions to describe patterns over time. Fast forward to look at the precipitation aspect of clouds, in second grade students had to obtain information to identify where water is found on Earth and that it can be solid or liquid (2-ESS2-3). Many students have already played the game, look at a cloud and make pictures from it. Different types of clouds contribute to these pictures. Students have also been exposed to rain and snow (living in Nevada), therefore those are familiar concepts, even if they don't necessarily know where they come from.

Lesson Body:

Engagement (7 minutes): In order to activate prior knowledge, we will make a cloud in class for the students to see. Later when we are talking about cloud formation, we can refer to the parts of this demonstration (Here is a lesson on clouds, N.D.):

1. Ask students what they think clouds are made out of and how they think clouds form. The responses to this question could be written on the board to return to later.
2. Explain to students that we are going to perform a simulation of the forming of a cloud. Take out the jar and have one of the students tape the black piece of paper onto one side of the jar. Ask another student to pour the warm water into the jar until it is one third full.
3. Light a match and hold it in the jar for a few seconds and then drop it in. At this point, have a student quickly cover the jar with the bag of ice.
4. Have another student (or teacher) shine the flashlight on the jar while all students observe.
5. Ask students what they saw (a cloud). Where did the cloud come from? (the bottom of the jar)

Exploration(15 minutes): Students will go outside and go on a cloud hunt. Start by letting students look at the clouds on their own, ask them to think about what the clouds are like in different weather. Provide groups with a cloud kit, index cards with pictures of labeled clouds.

Explanation(15 minutes): Start by handing out paper and having students fold it in half (hamburger style). On the top of the front, have students draw one of the clouds they saw while outside. Have several students show pictures of their clouds to the class. Have some draw their clouds on the board. Discuss how their drawings are alike and different. Explain that they may have all drawn different looking clouds because clouds come in all different shapes and sizes.

Have students flip to the blank inside of their folded papers and then talk about the three main categories that scientists use to classify clouds. For each cloud that we talk about (the three main types) have students write the name of the cloud at the top, what kind of weather it is associated with under that, and then draw a picture of that type of cloud.

- a. Cirrus clouds are thin and wispy; precede storms
- b. Cumulus clouds are white and puffy; shows fair weather
- c. Stratus clouds are low, flat, gray; often bring rain

This should all be demonstrated by the teacher at the front. After students finish their booklet, have them look at the front page again, in the space at the bottom, have students write what kind of cloud their picture is and why. Mention that there are other types of clouds, but these are the three main ones

Now that we know what clouds look like, what are they made of? Ask student to think about the intro activity they all saw.

- How did the warm water effect the cloud formation? (caused the water to evaporate and warmed the air, causing it to rise)
- What did the ice cubes do to help the clouds form? (cooled the air [made the water vapor condense]).
- What role did the match and its smoke play in the cloud formation? (gave the water something to condense or grab on to)
- Now what would you tell me a cloud is made of? (small water droplets)

Clouds need several things to form. How many of you have made a cake or cookies? What do you have to follow to make sure they come out right? A recipe? Well a cloud has a recipe with ingredients as well. Its ingredients are water, little particles in the air (like dust), and temperature change. What do you remember about temperature change?

If I say that a cloud is made of a lot of little water droplets, what do you think happens when there are too many water droplets in a cloud? They fall? Exactly, and what is that? Rain or snow? Which is also precipitation. When it is rainy out what does the air feel like? Do things dry as fast? That is because there is a lot of water in the air, which is also called moisture. This is what clouds can be like as well, they can have a lot of humidity, which means they are full of water. Do you think clouds are like anything? Maybe sponges? (TRB 4:2 - Investigation 1 – Clouds, 2004)

Elaboration(13 minutes): Students will do a humidity demo (that also shows how clouds can hold water). Talk with students about clouds, refer to earlier questions on board, what makes up clouds? (students should say some form of water) Oh, so there is water in clouds? Maybe clouds hold water like a sponge? We are going to do an experiment with a sponge.

1. Divide the class into groups of four students each. Distribute supplies (1 dry sponge on a plate, a cup of water, 1 plastic spoon).
2. Have the students squeeze the sponges so they can see there is no water in them. Ask the students how much water is in the sponge? (Answer: None)
3. One spoonful at a time, have the students *slowly* and *carefully* pour water onto the sponges. Have the students count how many spoonful's of water are being added and have one group member keep a tally.
4. After a few spoonful's, stop the students and ask them the following questions: What is happening to the water? Where is it going? What do you think is going to happen as you

keep filling the sponge with water? Can you put water into this sponge forever? Will we be counting forever?

5. Have the students resume adding water to the sponge by the spoonful until the sponge starts to drip water. Ask the students to explain what has happened to the sponge? Why is water dripping from it?

Ask students: What is humidity? How does it affect the weather? How is the sponge like a cloud?

6. Explain to the students that the sponge is like the air. Ask the students: How does the water dripping from the sponge act like rain or a cloud? Explain that air can "hold" water, too, similar to the sponge.

7. Ask the students to share how many spoonfuls it took to make their sponge full of water (Kolenbrander, Kotys-Schwartz, Yowell, Mach, Zarske, & Carlson, 2004)

Evaluation(10 minutes): Now that we have covered all of the different elements of weather, it is important for students to see how they relate to each other. Therefore, as a class, we will discuss how the elements relate to each other. In the process, we will review the other elements and how we have been measuring them. At this point, we will look back at our table to see how it is going. We will add a new column to the table, where students will write what clouds they see in the sky.

| Date | High or low atmospheric pressure | Temperature recorded for the day. | Wind speed | | Clouds in the sky | | |
|-------------------------|----------------------------------|-----------------------------------|------------|--|-------------------|--|--|
| How do we measure this? | Write high or low | Write the number | | | List the type | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Clean Up: After the engagement, students will carefully dump the water out of the big pickle jars. Once we return inside from the exploration, students will put their materials in the middle of the tables to be used for the later parts. Before starting the elaboration, students will carefully put away their other supplies so that there is room for the elaboration and nothing gets wet. After finishing the elaboration, students will wring out their sponges back into the original cups and then dump the water out. All of the supplies will be returned to the back table.

Closure: Today we learned how all of the elements of weather relate to each other, including clouds, precipitation, and humidity. We learned about the different types of clouds and how they form.

Adaptations, Accommodations and Modifications: Students have shared background experiences that will help with learning, since all students went through the first lessons in the

sequence. Out of all of the elements of weather, clouds are one of the most familiar, although there are new words associated with them. These new words will be placed on the board, to make sure that they are accessible by hearing and sight. In addition, the terms that need to be learned will be tiered. A foldable will be used to take notes in students' own words and will include pictures to help with the words.

Cloud Kits

Print one of each type of cloud (Stratus, cumulus, and cirrus), glue to index card, label the back, and place in zip lock bag. Cloud kits will have different pictures, but all must have one of each cloud.



References:

Here is a lesson on clouds. (n.d.). HotChalk Lesson Plans Page. Retrieved January 5, 2014, from <http://lessonplanspage.com/Sciencecloudslesson.htm/>

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TRB 4:2 - Investigation 1 - Clouds. (2004, July 26). UEN: Utah Education Network. Retrieved January 6, 2014, from <http://www.uen.org/Lessonplan/preview.cgi?LPid=10089>

Appendix E
Lesson Plan 5: Climate Versus Weather (Engineering too)

Number in Sequence: 5

Author: Kelsey Conklin

Grade: 3rd

Length: Two hours (expanded lesson over two periods)

Standards:

Next Generation Science Standards (NGSS):

2-ESS2-2: Obtain and combine information to describe climates in different regions of the world.

ESS2.D: Climate describes a range of an area's typical weather conditions and the extent to which these conditions vary over the years

3-ESS2-1: Represent Data in table and graphical displays to describe typical weather conditions expected during a particular season [Examples of data could include average temperature, precipitation, and wind direction]

ESS2.D: Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1)

CCSS Math

5-NBT-3: Read, write, and compare decimals to thousandths.

5-NBT-1: Understand the place value system.

CCSS ELA

3.L.6: Acquire and use accurately grade-appropriate conversational, general academic, and domain-specific words and phrases, including those that signal spatial and temporal relationships.

3.SL.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.

WiDA

ELD Standard 4: The Language of Science: Depending on level of student, students will be able to state reasons for or explain outcomes for certain events based on realia, sentence starters, and teacher guidance, with varying amounts of detail.

Content Objective: Students will be able to compare and contrast climate and weather as well as follow the engineering design process and implement their knowledge about climate.

Language Objective: Students will be able to successfully use climate and weather.

Table 5: Standards & Vocabulary Lesson Scaffolding Planning Chart

| BICS (Tier 1) Engagement & Exploration | BICS / CALP (Tier 2) Engagement & Exploration | CALP (Tier 3) Explanation, Elaboration & | Definition |
|-------------------------------------------------|--------------------------------------------------------|---------------------------------------------------|------------|
|-------------------------------------------------|--------------------------------------------------------|---------------------------------------------------|------------|

| | | Evaluation | |
|--------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | Pattern of weather Patrón del tiempo | Climate El Clima | The average weather in an area over a number of years, based on history. |
| Previously introduced | | | |
| | Outside A fuera | Weather El Tiempo | The state of the layer of air that surrounds Earth at a given time in a particular place. Temperature, humidity (precipitation and cloud cover), air pressure, and wind speed all contribute to weather. Estado de la atmósfera en un periodo y en un lugar determinados |
| Heavy Air El Aire Pesado | Air Pressure La Presión del Aire | Atmospheric/Barometric Pressure La Presión Atmosférica | The weight of the Earth's atmosphere over an area. El peso por unidad de superficie ejercida por la atmósfera. |
| Hot or cold Frío o caliente | | Temperature La temperatura | The degree of hotness or coldness of a body or environment Magnitud física que mide la sensación subjetiva de calor o frío de los cuerpos o del ambiente. |
| | Air movement El movimiento del aire patrón | Wind El Viento | The movement of air, which tends to move from a high pressure area to a low pressure area. Corriente de aire producida en la atmósfera por el encuentro de diferentes presiones en áreas distintas: |
| | | Cloud La nube | a visible form of water vapor floating in the atmosphere Una forma visible de agua que está en el aire. |

Materials:**Engagement:**

Typed up tables of the information students have been keeping (example format attached – fill in data from students and leave climate blanks open to look up together)

Exploration:

Weather forecast for the day

Group or individual computers with internet to look up climate data

Explanation:

Vocab strip with climate written on it

Pictures of different climate types and houses tailored for them

Elaboration:

Data table worksheet (with space to draw at the bottom)

Premade house bases (four pieces of cardboard stuck together to make four walls)

Masking tape

Duct tape

Assorted materials for houses – popsicle sticks, hay, roofing material, cardboard, felt, foil, saran wrap, clay, computer paper

Testing materials – strainer, tray, small squares of tissue paper, and water

Safety Measures Required: Students will be working with materials to create their own houses. They may need to cut and alter the materials, so it is important that they are very careful with scissors and other materials. In addition, they will be using duct tape, which sticks easily to everything and anything (including hair). Students should be warned about these aspects.

Unit Fit and Lesson Rationale: This lesson ties up all of the previous lessons by reviewing the aspects of weather, temperature, barometric pressure, wind, and clouds/precipitation/humidity. Students will look at all of the data they have collected in the past lessons. They will then learn about climate and compare it to the weather. Finally, students will make their learning more practical by creating houses and testing them in a tropical climate (pulling in engineering as well).

Teacher Content Background Knowledge: When we compare graphs of weather, we begin to see the relationship one weather factor has on the others. When we see freezing temperatures, the precipitation will be in the form of snow. Often when a storm is approaching from the north, the barometer will drop, there will be a strong south wind, many clouds will begin to form, and the temperature will rise. After a storm, the barometer will rise, the winds will be gentle, most of the clouds will be gone, and the temperature will be colder.

Williams says, “Air temperature differences on both a small scale and a global scale cause the winds. The air temperature near the Earth’s surface depends mostly on the surface temperature, because sunlight hardly heats the air as it passes through it. This means that the air above cool ground or water will become cool, and air above warm ground or water will warm up. Thus, variations in ground or water temperatures create different air temperatures around the globe and, to a smaller degree, over land and water. Warm air is light and tends to rise, while cold air is heavy and tends to sink. This is what causes the winds.

On a local scale, unequal heating causes “sea breezes” near the oceans or large lakes. As the land heats up during the day, air heated by the warmed land begins rising and cooler air flows in to replace it, creating a cooler breeze from the water to land.

On a global scale, this means that air tends to rise in the tropics and sink over cooler parts of the globe. If the Earth were not rotating, warm air would be rising in the tropics and flowing at high altitudes to the north and south, where it would sink in the polar regions. Cool air from the northern and southern parts of the globe would flow across the Earth’s surface to replace the rising air in the tropics.

The amount of water vapor, or humidity, the air can “hold” depends on the air’s temperature. Warm air can “hold” more water vapor than cool air. Anything that cools the air will cause water vapor to condense.

When the air is relatively warm, water evaporates into it, which means the water becomes the invisible gas known as water vapor. If the air is cooled, some of the vapor condenses to form dew, or the tiny water droplets that make up fog and clouds. (Fog is merely a cloud that’s nearer the ground.) When conditions are right, cloud droplets come together to create small drops, called drizzle, or larger raindrops. When the temperature is cold enough, water vapor can turn directly into ice to create frost on objects or snow in clouds.

“What is different between climate and weather? Weather happens at a particular time and place. For instance, Monday was hot, the sky was blue. Today it rained a trickle. Last week it snowed for two days straight. Weather. It keeps you guessing. It makes every day an adventure. Whatever the weather is doing now, it’s probably going to be doing something else in a matter of hours. Weather also can vary abruptly from place to place. Sometimes the places are very close together. It could be raining at your house, but dry at school a few blocks away. Climate is different. Climate is regional and long-term. Climate is the bigger picture of temperatures, rainfall, wind and other conditions over a larger region and longer time. Climate scientists (called climatologists) have sorted Earth’s regional climates into categories, or zones, based mostly on average temperatures and precipitation. These are the characteristics that determine whether a region is a tundra, a desert, or a rain forest. There are six climate zones in the world: tropical, dry, mild, continental, polar, and high elevation. Within each zone are further distinctions that indicate a more specific type of climate (What's the difference between weather and climate? n.d.).

The following from Shah, Zarske, and Carlson, (2006).

Tropical climates mainly occur in the tropical zone, which is the region of the earth between the Tropic of Cancer and the Tropic of Capricorn. Every point within this region receives perpendicular rays of the sun for at least one day of the year. The entire zone receives sunshine more directly than other areas, which results in a higher average annual temperature and less-dramatic seasonal changes than other zones. Instead of temperature changes, seasons are marked by rain changes, such as monsoon rains. **Warm a lot of the year, with lots of rain.** This region also contains the largest tropical rain forests: the Amazon and Congo. These forests have high amounts and variety of vegetation due largely to monsoon rains. High temperatures and rainfall make rubber, tea, coffee, cocoa, spices, bananas, pineapples, oils, nuts and lumber abundant for

use and export. Some cities with tropical climates are: Bombay, India; Dhaka, Bangladesh; Nairobi, Kenya; and Rio de Janeiro, Brazil

Desert climates generally refer to regions that receive little precipitation. Even so, they often have a wealth of life. Some of this life remains hidden during the daylight to preserve moisture. Soil in a desert region is often composed of sand, sand dunes, rocky terrain, and sometimes contains valuable mineral deposits. Desert classification is based upon a combination of the number of days of rainfall, total annual rainfall, temperature and humidity. **Little precipitation, hot days, cold nights.** Cold deserts can be covered in snow; these regions do not receive much precipitation and what falls remains frozen. These climates are often referred to as tundra. Most desert plants are drought- or salt-tolerant. Some of these plants store water in their leaves, roots and stems. Others have long taproots that penetrate the water table, anchor the soil and control erosion. Rain falls occasionally in deserts, and storms are often violent. Examples of deserts and desert climates are Moab, Utah

Alpine climates are generally above tree line, which is the altitude at which trees stop growing. At these high elevations, the climate becomes colder. This is described by the lapse rate of air, which refers to the phenomena of air getting colder as it rises, since it expands. **Low temperatures, high altitude, winds and short growing seasons.** Examples of alpine climates are the Tibetan Plateau and Vail, Colorado.

The **oceanic climate** is typically found along west coasts at the middle latitudes of all of the continents, and in southeastern Australia. Similar climates are also found at higher elevations in the tropics. These climates are characterized by a narrower range of temperatures and receive significant amounts of precipitation in the summer. Thus, precipitation is adequate and reliable at all times of the year. They are also usually classified as humid with respect to precipitation, except for Patagonia. Examples of oceanic climates are Barbados and the Galapagos Islands.

Cool temperatures and winds

Homes are designed in a particular way so that they work best in certain climates.

Different types of housing materials from Kessler (2004)

adobe: A brick or building material made of a sun-dried mixture of earth and straw.

igloo: An Eskimo house usually made of wood, sod or stone when permanent or of blocks of snow or ice in the form of a dome when built for temporary use.

pagoda: A Far Eastern tower of several stories erected as a temple or memorial.

tepee: A cone-shaped tent usually of skins used as a home by some Native Americans.

lodge: A house set apart for residence in a special season.

wigwam: A hut of the Native Americans of the Great Lakes region and eastward that usually has an arched frame of poles covered with bark, rush mats or hides.

People in different parts of the world use different materials to build their homes and other structures. When building homes, they must think about how to use these materials to build houses that work well for where and how they live.

In the southwestern part of the U.S. where the land contains a lot of clay and few trees, people build houses from adobe, a mixture of clay, straw and water. Adobe houses have thick walls that

keep the inside cool in the hot dry desert weather. Adobe houses would not be good in places where it rains a lot because too much water makes adobe crumble.

The weather in certain tropical islands in the Pacific Ocean is hot, but wet. People who live there make their homes from materials that are easy to find such as palm leaves, woven grasses and bamboo. Sometimes they build the houses on stilts to keep them off the wet ground and to let the breezes move under the house, helping to keep it cool.



Most Eskimos in Alaska and Canada build their houses out of sod or snow. These dome-shaped houses are called igloos. The dome shape of the igloo makes it very strong and able to withstand powerful winter storms. The thickness of the igloo also makes it a good insulator.

In the past, Native Americans built dome-shaped houses made of poles, leaves and tree bark., called wigwams. Native American tribes that moved frequently built cone-shaped tepees out of buffalo skins or bark. Tepees could be easily built and taken apart quickly. Some Native Americans lived in more permanent structures called lodges made from logs and sod.

When early American settlers came to New England, they found the ground covered with large stones. They used these stones to build houses, barns and fences that you still see in the region today. The northwest part of the U.S. and Canada has plenty of forests, so most houses are made of wood.

In parts of China where there are few forests, it is rare to see wooden houses. More often, they use tile, concrete and stone to build beautiful, multi-storied pagodas and other buildings. The land mass of China is so large and varied that almost every climate can be found.

In parts of Africa, where tall grasses grow, people weave the stems of dried grasses together to make thatch huts.

In Tibet, some people even make their houses out of wool! They shear the wool from ox-like animals called yaks. The wool walls keep the houses warm through the cold winter months.

Most houses in the U.S. today are built of a combination of wood, brick, stone, concrete, steel, aluminum, and glass.

Student Background Knowledge:

Students have not only been doing the lessons on weather that this lesson reviews (wind, clouds, temperature, atmospheric pressure), but also came in to third grade with prior knowledge. In addition, students have been gathering data from multiple sources, which not only has been taught in these lessons, but also in second grade, use information from several sources to provide evidence that Earth events can occur quickly or slowly (2-ESS1-1). Even before that, students were working with weather to use and share observations of local weather conditions to describe patterns over time (K-ESS2-1). Other life experiences have prepared students for this lesson as well. Many students already know that there are different weather patterns in different places and they have heard the term climate before, however, many do not know the difference between

climate and weather.

Lesson Body:

Engagement (10 minutes): Start by asking students, “So I looked at the weather today, and it said we are going to have this kind of weather...what kind of barometric pressure should we have? Temperature? Clouds? Wind? What do you remember about all of these?” Pass out prepared graphs of their collected data and lead students to notice patterns. What was our highest temperature? Lowest? Have we had a lot of rain? Have students explore the different ways the aspects of weather can connect:

When **temperature** changes, cool air and warm air meet and cause **wind**. Technically, the warm air is lighter and rising, while the cold air is heavier and sinking, causing wind

Warm air can hold more water vapor, which means when the air **cools off**, the vapor condenses into water droplets, which makes our **clouds**.

IF the clouds get full of water, it will rain. Depending on **temperature**, it may be snow or rain.

Lower air pressure brings **clouds and precipitation**. **High air pressure** brings **sunny skies**

Exploration:

After students have noticed the changes (or lack of changes) in the weather they have recorded, read them the climate for your area. Together, compare and contrast the information we have collected on weather and the climate forecast. Look up climate data to fill in the rest of the chart:

<http://www.usclimatedata.com/climate/reno/nevada/united-states/usnv0076>

Explanation:

Now that students see there is a difference in our “weather” and the climate information, ask why they might be different and see what students think. Eventually lead students to the idea that:

Weather: What is happening outside RIGHT NOW, depending on clouds, temperature, wind, and barometric pressure.

Climate: The pattern of weather over a period of time (years).

Have students share information on different climates (they should already be familiar with the type they live in). Show pictures of the different climate types and then houses that are in those climate types. Let students brainstorm why the different houses are good for the specific climates. Climates to include (Kessler,2004):

Desert: Hot days, cold nights, less precipitation



Desert houses can be made of **adobe** which is a clay

found in the desert. It is easy to access and therefore a good building material. It melts in the rain, but there is not much rain in the desert, so adobe is good to build with in the desert. The windows are set back from the edge of the walls to keep the sun out. The walls are also very thick to insulate the house and keep it cool.

Tropical: more sunshine, higher temperatures, lots of rain



Tropical houses may be made of palm leaves or woven grasses. They can also be built on stilts to keep them off of the wet ground. The roofs can be sloped to let the rain run off.

Alpine: above tree line, colder. Low temperature, high altitude, winds, and short growing season



Houses here may be made out of stone because it is an easily accessible material.



Coastal: humid, close to oceans, cool temperatures and winds.



Houses in this climate can be on stilts to avoid the water and windows may also be placed specially to catch the sun or avoid the water.



Other houses made for specific places include igloos, which also have thick walls to insulate, this time keeping the heat in. In addition, they have rounded roofs to be able to tolerate a lot of weight (snow).



In parts of Africa, where tall grasses grow, people weave the stems of dried grasses together to make thatch huts.



Have students think about how the climate in which they live affect how they live? Just like it affects us, it also affects our homes. Now that we have seen houses in different climates, what kind of houses do they see in our area?

Elaboration:

Students will be presented with an engineering challenge to start thinking about. They will start by planning it, and will complete and test it in the next lesson. Start by introducing the challenge and the materials that will be available.

Challenge: In your groups, you will be provided with a certain amount of materials to make a house. However, the house will be in a tropical climate, so what are some things you need to think about? (Students should answer that it needs to be waterproof). Reiterate that they will be working in groups, then introduce the materials. Each group will be provided with a house base. Four pieces of cardboard hot-glued together to make four walls. They will then get a limited supply of certain materials. Show and explain each material: duct tape, masking tape, a ball of clay, hay, shingles, cardboard, felt, computer paper, aluminum foil, and saran wrap. Demonstrate how we are going to test by pouring water through a strainer into a tray. Explain that their houses will sit in the tray and we will see if they are waterproof. A stand to set it on (like stilts) will be provided. Let students finish up by designing their house and drawing it on the data worksheet.

-----END OF DAY ONE-----

Elaboration continued:

Start day two by having students review their plans from day one, then review/introduce the engineering process.

What is our **problem**? Define it as a class

They then **brainstormed** as a group and started drawing

Next they will create a **plan** with their group and decide on the materials needed

They will then **build** their houses and **test** them

Finally, they will have a chance to **improve** their houses if needed

Then reintroduce the materials and the process for getting materials. Each group will have the following list. When they want materials, they must circle the items they want on their list and bring the list to the store at the front of the classroom. The storekeeper (teacher), will gather the materials and check off the items on their list. They can return to the store, but once an item is checked off, they cannot get any more of it.

- Duct tape (arm length)
- Masking tape (arm length)
- Ball of clay (palm sized)
- Three pieces of computer paper
- One square of aluminum foil (12x12)
- One square of plastic wrap (12x12)

- Four small squares of felt
- A big, medium, and small shingle
- A handful of hay
- Two pieces of cardboard
- Six popsicle sticks

Students will then have fifteen minutes to get their supplies and build. (More time can be given if they end up needing it, but start with a stopwatch on the board for fifteen minutes.)

When the time is up, the lights will go off and all hands must go up in the air. Houses will then be placed at the front of the room to undergo the rainstorms. Arrange everyone so they can see, place the stilts (a small cardboard platform covered in duct tape and plastic bags to be waterproof) on the tray, a small square of tissue paper on the platform and the house over the tissue paper square and on the platform (so it doesn't get wet from the bottom). Hold the strainer over the house and pour water for five seconds. Stop and remove the house, being careful to leave the tissue paper undisturbed, and check to see if it is wet. If it is not, the house is waterproof!

If the tissue paper is wet, have the class discuss ways it might be improved. Finish testing houses. If any houses were not waterproof, allow students ten minutes to try and improve their design, although they only get half of each of the earlier materials (for instance, three popsicle sticks or one piece of cardboard). Waterproof houses can also be improved upon, it could be adding artistic features or cleaning up unnecessary features. Houses will once again be tested in the same way.

Evaluation: This lesson reviewed for a later formal test, however, we will debrief from the elaboration and check student understanding. We will once again talk about the difference between climate and weather. Students will also be asked to talk about climate and the houses that go with certain climates. What would be important to consider for a desert climate?

Clean Up:

After finishing our elaboration, one student from each group will place all wet tested houses on the counter by the sink. Another student will bring any unused materials back to the store, while another student throws away any materials that cannot be used again. The last student in the group will wipe down the table.

Closure: Today, we learned about some of the jobs engineers do, as well as the engineering process. We used the engineering process to build a house that could survive a tropic climate.

Adaptations, Accommodations and Modifications: At this point, many of the terms used are terms that we have been discussing in our past lessons, there is only one new vocabulary term, so the content is not academic vocabulary heavy. In addition, a lot of the math portion (comparing the amounts of precipitation, wind, etc...) will be teacher guided to help all students access the material. The big part of this lesson is hands-on and group oriented, so students will have a chance to work with their peers. Finally, all students have experienced rain and already have ideas about what is waterproof and what is not, therefore, they all have background experiences.

This lesson could be modified or extended by having students create homes for a different climate, or by making the materials for any climate less available. For instance, students may only be provided with a few of the materials or less of each of them. This lesson could easily be tied in with other domains as well. More math could be added by provided students with a sum of money that they use to buy the materials, and once the money is gone, it is gone.

References:

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**Appendix F
Unit Assessment**

Use the words from our lessons to fill in the blanks. You only need to use the Spanish or English word, but feel free to use both. (Use las palabras de las lecciones para completar las frases. Solo necesita usar la palabra de inglés o de español, sin embargo, puede usar los dos.)

| | | | |
|--------------------|-----------------|------------------------|-------------|
| Temperature | Humidity | Air Pressure | Wind |
| La temperatura | La humedad | La presión atmosférica | El viento |

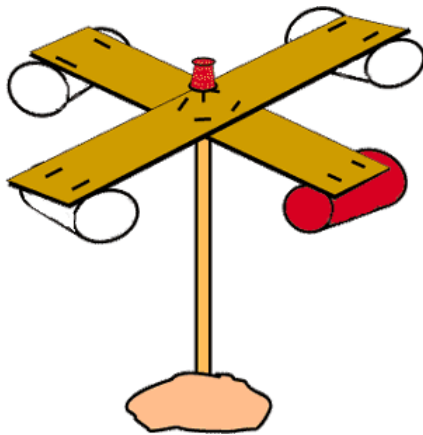
1. A barometer measures _____.
Un barómetro mide

2. _____ measures if it is hot or cold.
mide si hace calor o hace frío.

3. If you put your anemometer high on a mountain, you will measure a lot of _____.
Si pone el anemómetro muy alto en una montaña, medirá mucho

4. Precipitation and clouds are a part of _____.
La precipitación y las nubes son partes de

5.



This is a _____. How does it work?
Este es ¿Cómo funciona?

6. Describe how it would feel outside when the liquid in a thermometer

Describe como se sentiría afuera cuando el líquido en un termómetro mueve arriba.

moves up.

7. Draw a line between the word and the correct picture below.

Dibuja una línea entre la palabra y el dibujo correcto.

Cirrus Cloud

La nube cirro

Stratus Cloud

La nube estrato

Cumulus Cloud

La nube cúmulo

**8. Explain how two parts of the weather work together (for example, air**

Explica como dos partes del tiempo funciona juntas (por ejemplo, la presión atmosférica y la

pressure and temperature, clouds and wind, or temperature and

temperatura, las nubes y el viento o la temperatura y la precipitación).

precipitation).

9. The house below is located in a desert climate. Explain why this house is

La casa abajo está en un clima desierto. Explica porque la casa es perfecto para esta
good for a desert climate (give at least two reasons).

clima (por lo menos, usa razones).



10. Draw a picture showing your favorite weather. Explain why this is your

Haga un dibujo que muestra el tiempo favorito. Explica porque este es su favorito y etiqueta
favorite weather and label the picture.

las partes del dibujo.

What instrument(s) would you use to measure this weather? _____

¿Qué instrumento se usaría para medir este tiempo?

6. Describe how it would feel outside when the liquid in a thermometer

Describe como se sentiría afuera cuando el líquido en un termómetro mueve arriba.

moves up.

Must mention that it will feel warmer or hotter. Can talk about the heat making the liquid

expand and rise.

2 points – Students received a point for saying it would feel warmer, hotter, or even saying it feels like it's time to go to the beach. They received another point if they mentioned what happens in the thermometer.

7. Draw a line between the word and the correct picture below.

Dibuja una línea entre la palabra y el dibujo correcto.

3 points-

Matching
term to
picture

Cirrus Cloud

La nube cirro

Stratus Cloud

La nube estrato

Cumulus Cloud

La nube cúmulo



8. Explain how two parts of the weather work together (for example, air

Explica como dos partes del tiempo funciona juntas (por ejemplo, la presión atmosférica y la

pressure and temperature, clouds and wind, or temperature and

temperatura, las nubes y el viento o la temperatura y la precipitación).

precipitation).

Must list two weather elements and a reason they work together. Examples may include there must be a temperature change for clouds to form, different temperature levels cause different types of precipitation, low pressure usually predicts changes in weather (like storms). High pressure usually means fair weather and fair temperatures.

2 points – 1 point came from listing two elements that can actually work together (some mentioned the same element, for instance, rain and precipitation or air and wind, this was not counted. However, any form of the words was accepted, so rain or precipitation was fine, as long as something else was mentioned.) The second point came from a feasible reason they work together. Some examples that were accepted, wind and clouds work together to form a hurricane, rain and wind causing a storm, clouds and precipitation because water is in the clouds and makes precipitation, all work together for a storm, when wind blows temperature changes...

9. The house below is located in a desert climate. Explain why this house is

*La casa abajo está en un clima desierto. Explica porque la casa es perfecto para esta
good for a desert climate (give at least two reasons).
clima (por lo menos, dos razones).*



2 points – 1 point per reason. Any reasons associated with the house and climate were accepted, however, just describing it as why it is a desert climate (but no information on the house) did not get points.

Must mention two reasons, for instance, small windows to limit sun exposure; windows under

overhangs to limit sun exposure; building material is adobe, which is thick and will keep the cool

air in; adobe is made of straw and mud, which is found in this climate; or adobe is not draught

tolerant, which is fine because there isn't much rain in this climate.

10. Draw a picture showing your favorite weather. Explain why this is your

*Haga un dibujo que muestra el tiempo favorito. Explica porque este es su favorito y etiqueta
favorite weather and label the picture.*

las partes del dibujo.

4 points – 1 point for a picture showing a favorite weather, seasons were not accepted (for instance, winter). 1 point for labels (points were given if the explanation contained information for labeling. For instance, no labels, but the sentence says “Rain is my favorite weather because...”) 1 point for any explanation, as long as it answered why. 1 point for an instrument that could feasibly measure the weather (or a part that was explained). A barometer was accepted for good or bad weather (since this was talked about that). A thermometer was accepted for warm or nice weather, however it was not accepted for a rainy or snowy day, unless they said something in their explanation about it being cold. Weather station as an instrument was accepted.

Picture must show one element of weather that we have studied with labels and any reason why.

What instrument(s) would you use to measure this weather? Must list appropriate instrument(s)

¿Qué instrumento se usaría para medir este tiempo?