

INQUIRY-BASED LEARNING SCIENCE CURRICULUM FOR
KINDERGARTENERS

by Meghan Brady

A capstone submitted in partial fulfillment of the requirements for the degree of Master
of Arts in Teaching.

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PROJECT DESCRIPTION

I created a science unit plan for kindergarten students to explore the Next Generation Science Standards of weather, engineering, and Earth science. My curriculum incorporates inquiry-based learning to engage the students with science content knowledge. My goal is for the students to meet the science standards provided by the NGSS with high engagement and an ability to demonstrate understanding of the content. My research question is: *How can teachers utilize inquiry-based learning while assessing success in kindergarten science education?* Inquiry-based learning encourages student-centered learning, as opposed to the teacher delivering all the information. My curriculum provides a unit plan for teachers to implement in their classrooms to encourage inquiry and demonstrate understanding through student assessment.

My unit plan will address the following standards taken from Next Generation Science Standards (2019):

Students who demonstrate understanding can:

- K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
- K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- K-2-ETS1-3. Analyze data from tests of two objects.

- K-PS3-1. Make observations to determine the effect of sunlight on Earth's surface.
- K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.
- K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time.
- K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

This curriculum is a two-week science unit for kindergarten students in the month of January. There are ten 30-minute lessons in the unit plan. The unit can be used at other times of the year however; I would not recommend this unit early in the school year. I would recommend waiting until the class has established routines and procedures for inquiry-based learning and group work.

My units will be based on a lesson packet available on Teachers Pay Teachers. This unit is created by teacher-author Sue Calahane (Calahane, 2013). She created a unit plan to address the NGSS titled "Weather and Temperature." Her lessons allowed the children to learn about weather, while integrating those intimidating engineering standards. I plan to use some of her original ideas to support my activities to achieve the goal of authentic assessment of the NGSS while using inquiry-based learning activities.

This unit was created following the *Understanding by Design* model created by Wiggins and McTighe (2011). This curriculum design model follows a backwards design approach. The lesson is created with the result in mind. For this science unit plan, I will

start with the standards I want my students to demonstrate understanding of and work backwards from there.

Wiggins and McTighe's *Understanding by Design* (2011) explains three steps to creating lessons that follow the backwards design approach. The first stage is to identify desired results (Wiggins & McTighe, 2011). During this stage, the teacher will need to select the standards the students will need to demonstrate understanding of the content knowledge. The backwards design approach works very well with inquiry-based learning and the Next Generation Science Standards because of this focus on the first stage. Starting with the learning goal, or standard, is a great way to ensure focus on the NGSS. The focus on the standard will also lend itself well to the integration of inquiry-based learning while ensuring those activities provide value and engagement with the core science knowledge.

The second stage of Wiggins and McTighe's curriculum design approach is to determine acceptable evidence (Wiggins & McTighe, 2011). This stage requires the teacher to think of different demonstrations of understanding. What evidence presented by the students will demonstrate learning? This step will have the teachers think of the different types of assessment and what will be considered proficient for accomplishing that specific standard.

The third stage is to plan learning experiences and instruction (Wiggins & McTighe, 2011). Teachers will now work towards creating valuable lessons and inquiry-based activities. Since this is the last step teachers will be focused on creating lessons that focus on the standards and creating authentic assessment.

I will follow this curriculum design model by following these three stages towards creating authentic and engaging science units. By working from the standard, to the assessment, and finally to the activities I will be sure my lessons are focused on helping my students demonstrate understanding of the science content knowledge. Wiggins and McTighe's backwards design (2011) will help me answer my research question: *How can teachers utilize inquiry based learning while assessing success in kindergarten science education?*

LESSON PLANS

Unit Title: Weather and Temperature Subject: Science Grade: Kindergarten	Teacher: Mrs. Meghan Brady Duration: Two weeks (10 half hour lessons)
<p>Summary of unit: This unit plan is a two-week unit designed for Kindergarten students to meet the NGSS Standards in energy, engineering and Earth’s systems. The unit will allow students to explore, investigate and solve problems. This plan will answer the research question: <i>How can teachers utilize inquiry-based learning while assessing success in kindergarten science education?</i> The lessons are designed to be completed during a 30-minute period. Students will learn about recording weather observations, learning about the sun, using thermometers to measure temperature, observing the impact of the sun on the Earth, and building a structure to provide shade.</p>	
Stage 1 – Desired Results	
<p>Objectives/Standards:</p> <ul style="list-style-type: none"> ● K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool. ● K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem. ● K-2-ETS1-3. Analyze data from tests of two objects. ● K-PS3-1. Make observations to determine the effect of sunlight on Earth’s surface. ● K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area. ● K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time. 	<p>Essential Questions:</p> <ul style="list-style-type: none"> ● How do we measure temperature? ● What is the weather like today? ● How do we protect ourselves from the Sun? ● What is the effect of the sun on the Earth?

<ul style="list-style-type: none"> ● K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs (Next Generation Science Standards, 2019). 		
<p>Factual Knowledge Students will know:</p> <ul style="list-style-type: none"> ● The sun is a star. ● It provides heat to Earth. 	<p>Procedural Knowledge Students will be able to:</p> <ul style="list-style-type: none"> ● Measure temperature. ● Analyze data. ● Document weather and temperature. 	<p>Conceptual Knowledge Students will understand:</p> <ul style="list-style-type: none"> ● How to design a solution to a problem.
<p>Stage 2 – Assessment Evidence</p>		
<p>Performance Tasks:</p> <ul style="list-style-type: none"> ● Students will ask questions about weather, temperature and the sun. ● Students will track the weather and temperature using a calendar book. ● Students will measure the temperature of water and ice water. They will document and compare the temperatures. ● Students will watch a video about the sun. They will write and draw about what they learned about the sun and its impact on the Earth. ● Students will compare the temperature of different materials out in the sun to see which gets hotter. ● Students will design a shade structure to limit the impact of the sun. 	<p>Unit Pre-Assessment:</p> <ul style="list-style-type: none"> ● We will create a KWL chart as a group to assess what we know about weather and temperature and what we want to know. We will complete our chart on day 10 by answering our questions and documenting what else we have learned. <p>Other Evidence/Assessments:</p> <ul style="list-style-type: none"> ● Each student will utilize their science journals for our unit on weather and temperature. In it will be each performance task to demonstrate their understanding. Their learning will be demonstrated through writing, drawing, and photographs. The science journal will serve as the summative assessment for the unit. 	

<ul style="list-style-type: none"> ● Students will build a shade structure to limit the impact of the sun. 	
<p>Extensions:</p> <ul style="list-style-type: none"> ● For those students who are ready for a challenge, they will be asked to measure temperature to the degree (the rest will estimate, for example, 64 degrees will be marked as between 60 and 70). ● This unit will include writing activities. There will be an opportunity to extend the writing by writing more and independently. 	<p>Differentiation Considerations:</p> <ul style="list-style-type: none"> ● Using a thermometer to measure temperature is a new concept to most kindergarteners. The expectation is that students will be able to measure to the nearest ten. Students will work with a partner and have the assistance of the teacher if needed. ● Writing activities will be differentiated using sentence starters, cut and paste sentences, invented spelling, and the use of pictures to represent ideas.
Stage 3 – Learning Plan	
Lesson Descriptions	
<p>Lesson 1: Introduce the unit on weather and temperature.</p> <p>Objective:</p> <ul style="list-style-type: none"> ● Students will ask questions about weather, temperature and the sun. ● Students will track the weather using a calendar book. <p>Materials Needed:</p> <ul style="list-style-type: none"> ● Chart paper ● Post-it notes ● Markers ● Fiction book about weather <ul style="list-style-type: none"> ○ Examples of possible books: <i>Sun</i> by Sam Usher, <i>Cloudy With a Chance of Meatballs</i> by Judy Barrett, <i>Oh Say Can You Say What's the Weather Today?</i> by Tish Rabe, or <i>Freddy the Forecaster</i> by Janice Bean ○ Feel free to substitute with any weather stories available in your school or class library 	

Assessment:

- Class will create a KWL chart as a group to demonstrate what they KNOW about weather and what we WANT to know. We will complete the chart at the end of the unit with what we have LEARNED.

Procedure:

- Students complete calendar books with routine established throughout the school year. Students fill in the date on the correct square in their calendar books. Next, they record the weather for the day (cloudy, rainy, snowy, or sunny) (see Appendix A).
- Teacher reads aloud a fictional story about weather. Teacher can choose any story from your class library. The idea is just to expose your students to the topic and create interest.
- Teacher and students create KWL chart in front of class. Complete the “K” KNOW and “W” WANT TO KNOW areas. Save the last chart for “L” WHAT WE LEARNED.
- Teacher asks students to think about what they know about weather and temperature.
- Teacher has students share ideas with their floor buddy first, then they display they are ready to share by holding up hands in a pyramid.
- Teacher asks several groups to share out what they already know about weather and temperature, recording on the Post-it notes.
- Teacher repeats procedure for what we want to know. Next, teacher asks for questions about weather and temperature.
- Teacher records all questions on KWL chart and keeps the chart displayed for the duration of the unit.

Lesson 2: Temperature.

Objective:

- Students will track the weather and temperature using a calendar book.

Materials:

- Calendar books
- Computer and projector
- Brainpop, Jr. access (register for a membership at brainpopjr.com)
- Link to BrainPop, Jr video - <https://jr.brainpop.com/math/measurement/temperature/>
- Link to BrainPop, Jr quiz - <https://jr.brainpop.com/math/measurement/temperature/easyquiz/>
- Document camera

Assessment:

- Students will record today’s temperature in their calendar books.
- Students will participate in Brainpop, Jr. quiz with their floor buddy and share out answers.

Procedure:

- Students complete calendar books with routine established throughout the school year. Students fill in the date on the correct square in their calendar books. Next they record the weather for the day (cloudy, rainy, snowy, or sunny) (See Appendix A).
- Today, we add the step of recording the high temperature for the day.
- Class comes to the carpet to watch the BrainPop, Jr. “Temperature”
- Teacher demonstrates how to record temperature with document camera in teacher calendar book (See Appendix B).
- Class goes back to their tables to record temperatures in their own books. Teacher checks for completion by walking around the room. Students return to the carpet.
- Class completes the easy quiz on BrainPop, Jr. as a group. Teacher reads questions and class whisper answers to their floor buddies. We choose an answer and see how we did.

Lesson 3: Using a thermometer.

Objective:

- Students will track the weather and temperature using a calendar book.
- Students will measure the temperature of water and ice water.
- Students will compare the temperatures of water and ice water.

Materials:

- Calendar books
- Thermometers (One per student)
- Plastic cups (One per student)
- Ice
- Water
- Thermometer cut outs (See Appendix C)
- Science journal
 - Note about science journal: This is a primary composition book. Half the page is for pictures and the other half has primary writing lines. These are sold online or at teacher supply stores. This is used year round for science instruction in my classroom.

Assessment:

- Students will record the temperature of the water and the ice water by coloring it in on the thermometer.

Procedure:

- Students complete calendar books with routine established throughout the school year. Students fill in the date on the correct square in their calendar books. Next they record the weather for the day (cloudy, rainy, snowy, or sunny) (See Appendix A).

- Students record temperature in their own calendar books. Teacher checks for completion by walking around the room. Students return to the carpet (See Appendix B).
- Students sit in a circle on the carpet while the teacher demonstrates the activity.
- Teacher shows how to measure temperature of water in the cup. Teacher records on her own sheet (model how to record by saying “it is about halfway between 40 and 50, so my line is halfway).
- Teacher explains that students will do the same with their own water cup and then repeat with ice water.
- Teacher places one water cup and one ice water cup on tables per pair of students.
- Students go to table to measure temperature of water and ice water.
- Teacher helps students needing assistance and prompts other students to measure by the ones instead of estimating the tens.

Lesson 4: The sun.

Objective:

- Students will track the weather and temperature using a calendar book.
- Students will write and draw about what they learned about the sun and its impact on the Earth.

Materials:

- Calendar books
- Brainpop, Jr. access
- Link to BrainPop, Jr. video - <https://jr.brainpop.com/science/space/sun/>
- Computer and projector
- Printer
- Glue
- Scissors
- Colored pencils
- Science journal

Assessment:

- Students will write and draw to answer the question “How does the sun impact the Earth?”

Procedure:

- Students complete calendar books with routine established throughout the school year. Students fill in the date on the correct square in their calendar books. Next, they record the weather for the day (cloudy, rainy, snowy, or sunny) (See Appendix A).
- Students then record temperatures in their own books. Teacher checks for completion by walking around the room. Students return come back to the carpet (See Appendix B).

- Class watches “The sun” Brainpop, Jr. on the projector screen.
- Teacher gives focus question to the class “How does the sun impact the Earth?”
- Teacher asks the class this question and have them share ideas with their floor buddy, then they share out with the class.
- Students are to write and draw their answer to the question in their science journals.
- Students are given time to write and draw about the sun.
- Based on literacy assessments some students will be given sentence scrambles based on their idea or sentence starters to help scaffold their writing.
- Example of sentence scramble: Sentence (allow students to self-generate) “The sun is a star.” Type and print out the sentence “is star. The a sun”. Students will cut and paste in the correct order.
- Example of sentence starter: type and print out “The sun can.... ” or “The sun is... “. Students will paste this in their science journal and complete the sentence.
- Once students have completed their writing and drawing they share their work with their tablemates and then can share out with the class.

Lesson 5: Measuring temperature on different surfaces.

Objective:

- Students will track the weather and temperature using a calendar book.
- Students will compare the temperature of different materials out in the sun to see which gets hotter.

Materials:

- Calendar books
- Thermometers (One per student)
- Thermometer cut outs (See Appendix C)
- Science journals
- Chart paper
- Markers

Assessment:

- Students will measure and record the temperature of different surfaces in the schoolyard.
- Students will compare the temperatures and see which item gets the hottest.

Procedures:

- Students complete calendar books with routine established throughout the school year. Students fill in the date on the correct square in their calendar books. Next they record the weather for the day (cloudy, rainy, snowy, or sunny) (See Appendix A).

- Students then record temperatures in their own books. Teacher checks for completion by walking around the room. Students return come back to the carpet (See Appendix B).
- Teacher reviews how to measure temperature using a thermometer by allowing students to measure the temperature of the classroom. Each student is given one thermometer, three thermometer cut-outs, and their science journal.
- Students measure the temperature of the room by placing their thermometer on their table. They share and compare with their tablemates. Teacher conferences with each group to ensure they are reading the thermometers correctly.
- Teacher explains their task for the day. Students each measure and record the temperature of three different surfaces in the school yard. Examples include: basketball court, soccer field, slide, tunnel on play structure, picnic tables, ramps into the school, etc.
- Students need to select three areas to measure the temperature. Before going outside, they glue down the thermometer cut-outs in their science journal.
- During work time, students go outside to measure and record the temperatures. They work with their floor buddy. Partners can help each other measure and record, but also give time to work together and keep each other accountable.
- After 10-15 minutes, bring the students back inside.
- Class discusses the findings. Teacher records different surface temperatures on chart paper. Key questions: What surface was the hottest? Do we have a hypothesis for why that is? What surface was the coolest? Why is that? Did we get the same temperatures for the same surface?
- NOTE: Send home a note for students to bring in a small toy for days 7-10 (Lego person, stuffed toy keychain, action figure, etc)

Lesson 6: Introduction to STEM activities

Objective:

- Students will track the weather and temperature using a calendar book.
- Students will work with their floor buddy to build the longest paper chain with limited materials.
- Students will work together to solve a problem.

Materials:

- Brainpop, jr. access
- Link to BrainPop, Jr. video - <https://jr.brainpop.com/artsandtechnology/technology/engineeringanddesignprocess/>
- Computer and projector
- Construction paper
- Scissors
- Tape
- *Rosie Revere, Engineer*

Assessment:

- Teacher will monitor students' ability to communicate with their partner to solve a problem.

Procedures:

- Students complete calendar books with routine established throughout the school year. Students fill in the date on the correct square in their calendar books. Next they record the weather for the day (cloudy, rainy, snowy, or sunny) (See Appendix A).
- Students then record temperatures in their own books. Teacher checks for completion by walking around the room. Students return come back to the carpet (See Appendix B).
- We begin our introduction into STEM by reading *Rosie Revere, Engineer*.
- Teacher should point out skills during read aloud such as asking questions, solving problems, being persistent, and working together.
- After read aloud, teacher asks students "How did Rosie solve her problems?"
- Teacher leads discussion on this topic.
- Students watch BrainPop, Jr. titled "Engineering and Design Process."
- Teacher explains idea of STEM, this is solving problems using science, technology, engineering, and math. We learned these words from our read aloud and the BrainPop video.
- Teacher presents a new challenge to students. They need to build the longest paper chain they can with only one piece of construction paper, some tape and a pair of scissors.
- Students work with their floor buddy to build the paper chain.
- Teacher allows 10-15 minutes of work time. Teacher prompts students as needed but allow them to attempt their ideas and struggle a little, if necessary.
- Teacher takes pictures of groups as they work for students to add to their science journal.
- After work time, teacher has all the students come back to the carpet.
- Teacher leads discussion on how to create long paper chains. Have students share their strategies, successes, and challenges in this assignment.

Lesson 7: Planning day.

Objective:

- Students will track the weather and temperature using a calendar book.
- Students will design a shade structure to limit the impact of the sun.

Materials:

- Science journal
- Small toy (be sure to provide extras if kids forget them from home)
- *Iggy Peck, Architect*
- Paper towel tubes
- Toilet paper tubes
- Cardboard boxes

- Yogurt containers
- Construction paper

Assessment:

- Students will draw their plan for creating a shade structure.

Procedures:

- Students complete calendar books with routine established throughout the school year. Students fill in the date on the correct square in their calendar books. Next, they record the weather for the day (cloudy, rainy, snowy, or sunny) (See Appendix A).
- Students then record temperatures in their own books. Teacher checks for completion by walking around the room. Students return come back to the carpet (See Appendix B).
- Teacher introduces new STEM challenge to summarize our weather unit. Students are tasked with designing and building a structure to provide relief from the sun for their toys.
- This activity is based on the activity created by Sue Cahalane in the unit plan titled “Weather and Temperature” (Cahalane, 2013).
- Teacher should tie in memories of playing outside on hot days. What happens to us on a hot day? Teacher creates a need for a shaded place to play.
- Teacher displays building materials such as paper towel tubes, toilet paper tubes, cardboard boxes, yogurt containers, and construction paper.
- Students are to draw and write (if desired) a plan for their shade structure in their science journals.
- Teacher’s role is to help brainstorm, guide and motivate the student thought process. Teacher should not give examples of shade structures. Teacher should allow the students to think creatively.
- Teacher monitors work by walking around the classroom and conducting mini conferences with each student. These should not take more than a minute or two. Teacher should ask about their plan and provide support.

Lesson 8: Building day.

Objective:

- Students will track the weather and temperature using a calendar book.
- Students will build a shade structure to limit the impact of the sun.

Materials:

- Paper towel tubes
- Toilet paper tubes
- Cardboard boxes
- Yogurt containers
- Construction paper
- Scissors
- Tape

- Science journal
- Small toy (be sure to provide extras if kids forget them from home)

Assessment:

- Students will build a shade structure to protect their toy from the impact of the sun.
- Teacher will take photos of the building process and final product to add to their science journal.

Procedures:

- Students complete calendar books with routine established throughout the school year. Students fill in the date on the correct square in their calendar books. Next, they record the weather for the day (cloudy, rainy, snowy, or sunny) (See Appendix A).
- Students then record temperatures in their own books. Teacher checks for completion by walking around the room. Students return come back to the carpet (See Appendix B).
- Teacher reviews their assignment. Students have a task of creating a shaded area for their toys to play on a hot sunny day.
- Students collect their building materials and supplies for their shade structures.
- Students are given about 20 minutes to work and build their shade structures today.
- Teacher takes photos of the building process and final product to add to their science journal.

Lesson 9: Testing day.

Objective:

- Students will track the weather and temperature using a calendar book.
- Students will measure the temperature of two different surfaces.
- Students will compare temperatures.

Materials:

- Thermometer
- Science journals
- Thermometer cutouts (See Appendix C)
- Toy
- Shade structures

Assessment:

- Students will measure and record the temperature inside and outside of their shade structure.

Procedure:

- Students complete calendar books with routine established throughout the school year. Students fill in the date on the correct square in their calendar

books. Next they record the weather for the day (cloudy, rainy, snowy, or sunny) (See Appendix A).

- Students then record temperatures in their own books. Teacher checks for completion by walking around the room. Students return come back to the carpet (See Appendix B).
- Teacher explains today's task of testing the shade structure. Students will evaluate if the structure protects their toy from the sun by measuring the temperature inside and outside the shade structure.
- Teacher hands out two thermometers cut outs to each student. Student glues down the thermometers before going outside.
- Students bring their shade structures, science journals, and thermometers outside.
- Students will place their shade structures on the school yard. They should place one thermometer inside the shade structure and one on the pavement.
- Students measure and record each temperature in their science journal.
- Class returns to the classroom with all their materials.
- Teacher leads discussion on the results from testing the shade structures. What was the temperature inside the structure? What was the temperature on the pavement?

Lesson 10: Reflection day.

Objective:

- Students will track the weather and temperature using a calendar book.
- Students will write and draw to reflect on their learning from the weather unit.

Materials:

- Science journal
- Pictures of student work
- KWL chart

Assessment:

- Students will write and draw about their work in the unit.
- Students will assemble a portfolio to demonstrate their learning in the unit.

Procedures:

- Students complete calendar books with routine established throughout the school year. Students fill in the date on the correct square in their calendar books. Next they record the weather for the day (cloudy, rainy, snowy, or sunny) (See Appendix A).
- Students then record temperatures in their own books. Teacher checks for completion by walking around the room. Students return come back to the carpet (See Appendix B).
- Teacher reviews the KWL chart created on day one. Class works to answer the questions from the "W" category. Teacher can assist answering unknown questions by researching on the internet.

- Class works to create a list of items they learned from this unit. Teacher records answers in the “L” category.
- Teacher has students work in their science journals to reflect on our weather unit. Students glue down pictures of their final project and the different activities. Students write and draw about what they learning activities they completed.

APPENDIX A



January



Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

Money grab! Pull a coin out of the bag and write the value in a square.

(Pederson, 2012)

APPENDIX B

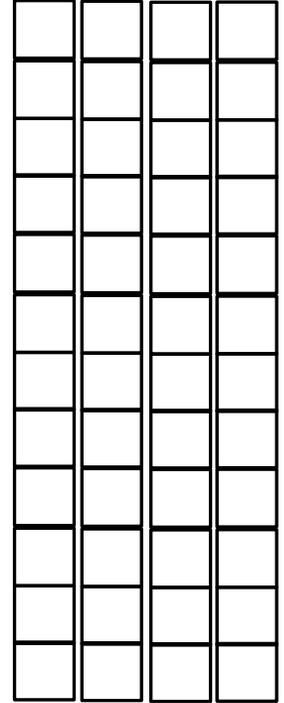
January Weather Tracker

Draw the weather symbol
Write the temperature in the circle.



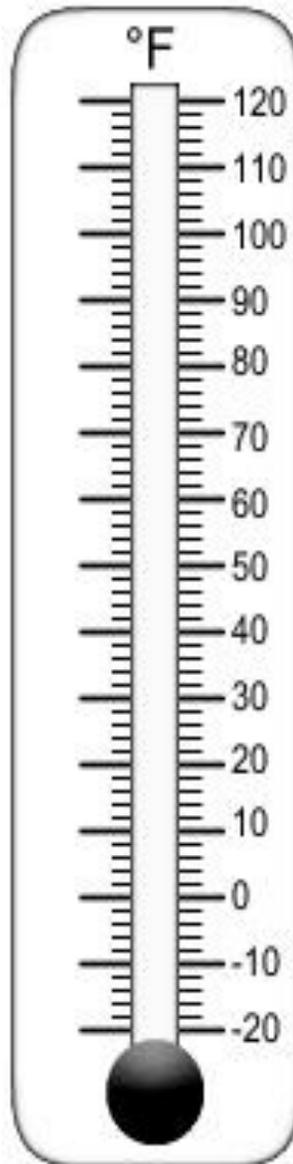
Daily Bar Graph

Monday	Tuesday	Wednesday	Thursday	Friday



(Pederson, 2012)

APPENDIX C



(Pederson, 2012)

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