Weather Moves, So Should Children

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This curriculum unit is recommended for:
Fifth Grade Earth Science, Weather

Keywords: brain, BDNF, Irisin, neurogenesis, exercise, weather, air, water, weather systems, air mass, jet stream, convection current, wind

Teaching Standards: See Appendix 1

Synopsis:

This unit will be taught after facilitating lessons on changing matter, specifically conduction, convection, or radiation, and as a lead into global weather patterns. The key points to be focused on are the cause and effect relationships in weather, air temperature, and movement as well as water temperature and movement. Each lesson will be focused around the students moving and "becoming" the types of matter as it relates to weather. Research shows that ten minute breaks with physical activity helped students to focus and retain information immediately following their break. Each class focuses on connecting content to movement, which elevates their heart rate and provides more blood circulation to the brain. This movement will support neurogenesis, memory and attention. I developed this unit to evoke change in the way we are teaching our students challenging topics. My students have struggled with global weather patterns and understanding their brain development can only facilitate the learning process.

I plan to teach this unit during the coming year to 90 students in 5th grade science classes.

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Amethyst Klein

Introduction and Rationale

Children are natural movers and are frequently asked to go against their natural instincts and sit still. The only living things that have brains are those that have the capability of movement. With this knowledge, educators should not be fighting against nature but working with it. There are so many challenges that we are faced with on a daily basis - children moving should not be one of them. If we design lessons with nature in mind they will encourage student movement, which, in turn, will stimulate brain growth and aide in the retention of information.

After 12 years of teaching Kindergarten through 5th grade in various capacities I have struggled with finding balance between rigid instructional times and reaching the whole child. There does not have to be a struggle, teaching with the whole child in mind allows for opportunities to teach/learn while promoting healthy child development. One way to facilitate this process is to integrate more movement.

Realizing the value in "wiggle breaks" for younger students was the beginning, and addressing their need for movement now would save me time later. These "wiggle breaks" became "brain breaks" for the older students, who shared this need to release energy. These breaks were no longer than two or three minutes because I only had a fraction of time with them. I could not afford to take any more instructional time so I integrated minimal whole child strategies, where I could. I knew I needed to do more.

I have always been interested in brain development and using it to my advantage while teaching but never had the time to devote to learning about the brain. While attending a regional STEM conference where the keynote speaker was a neuroscientist my motivation was kicked into high gear. The opportunity of Charlotte Teachers Institute appeared and they were offering *Exercise and the Brain*. This was the perfect opportunity to tweak my teaching strategies, enhance my lessons, and learn true rationale behind them.

The weather content knowledge expected of 5th graders is elaborate. Each year the data (formative and summative assessments, including the EOG) told the same story: I needed to do something differently to help my students succeed. Instead of reinventing the wheel or taking extra time with trial and error, my past curiosity of the brain proved useful. The brain is a tool that is available to all, rarely used to its full potential, and under budget. While attending each seminar I had my goal of creating lessons to engage students' minds, not only consciously, but subconsciously and stimulate brain growth through movement.

Background and Instructional Content

Meteorologists have vast knowledge of air, water, and natural forces at work in order to predict the weather and have chosen this field as their focus. Children have misconceptions and their own motivators when attending science class. Students have listened to stories about clouds crying, thunderstorms are giants bowling or having an argument, clouds are made of cotton and the sun disappears when it is nighttime. They need to make connections to realize that this information is important to their lives. Brain research is particularly important when realigning misconceptions and motivating student engagement.

We store information for every part of our lives in our brain, intentionally and subconsciously. Teachers have the goal for students not merely to remember information from class but to have mastered the content. A stepping-stone to mastery is tapping into their memory. If students struggle to remember information from a previous class they lack the prior knowledge to connect to the new material. Teachers can use knowledge of students' working memory to capitalize on their long-term memory and working memory is directly related to attention (1). If we hold their attention we can support their working memory. What better way to hold their attention then to associate body movements with content! Throughout this section, I will provide the vertical alignment of content and valuable brain research in support of movement.

Kindergarten gives children their first school experience with observing the weather and allows them to use proper vocabulary with their observations. This introduction to science also allows for recording of information, a weather journal, which could be used to recognize patterns, analyze differences in weather, including seasonal changes.

Second grade is the next time students are encouraged to be meteorologists. These opportunities expand on their first experiences, to include specific weather conditions while using tools for each measurement. The data they collect is to be used as a guide for them to make predictions about upcoming weather changes. Second grade is also the first time the students spend a significant amount of time recognizing the sun's role. However, this recognition is the idea that the sun provides energy to increase the temperature of land, air, and water.

In their final year of elementary school students combine their knowledge of earth materials, matter, energy and weather in their weather standards. They continue to collect weather data through specific measurements and observations. The largest leap in content is the inclusion of global weather patterns. Students now need to be effective in their analysis between the cause and effect of various weather phenomena across the country. These include but not are not limited to jet streams, El Nino and La Nina, Westerly winds, and hurricanes.

This unit's activities will focus on the final section of this objective - 5.E1.3.

Molecules and Pressure

In order for students to analyze local weather conditions they need to have a solid understanding of how temperature affects the molecules in air and water. Luckily air and water molecules act very similarly. As heat energy is transferred to water and air molecules they move faster and spread apart, heat rises.

When heat energy is lost, air and water molecules move closer together and slow their motion. When molecules are closer together the matter is more dense and sinks, molecule movement and density are inversely related.

As the temperature and movement of molecules change so does the pressure. Students should know that air and water is subject to gravity, resulting in pressure. Cold air has high pressure because the molecules are closer together (they are working together to push objects). High pressure systems sink. Warm air has low pressure because the molecules are spreading apart (they are working separately and have less force individually). Low pressure systems rise up.

Humidity

The amount of water in the air is referred to as humidity. Because matter takes up space, where there is more space available there will be more water. Warmer temperatures are associated with humidity because as the molecules spread farther apart they are leaving more room for water to fit.

Location and Temperature

The temperature of Earth materials varies based on their location, specifically their latitude and altitude. Materials at smaller degrees of latitude are heated by the sun with direct rays. These direct rays transfer more heat energy to the materials. Materials at higher latitudes receive indirect rays of heat energy from the sun, which results in lower temperatures.

However, when two locations on the same latitude levels are at different altitudes the air molecules behave differently. As altitude increases, air pressure decreases. This decrease in air pressure leads to lower temperatures. When warm, less dense air, is forced up quickly i.e. up a mountain, there are often rain showers. The water is forced out of the air because the air molecules are forced closer together because an increase in altitude. After/When all the moisture is pushed out of the air on one side of the mountain the other side of the mountain is left dry.

Heating of Earth Materials

Back in second grade students learned that the sun's energy heated land, water, and air. By gathering that data they could recognize that the temperatures are not the same, even though the sun heated them the same way. In 5th grade their understanding of molecules should include the difference between solids and liquids and gas. Knowledge of molecules and their movement is helpful for analyzing the speed with which land and water heat and cool. Land (solids) are able to change temperature more quickly than water (liquid) which is more stubborn when it comes to changing temperature. These temperature changes are what cause land and sea breezes.

Convection Currents

Because material and location affect the temperature there is uneven heating. Uneven heating is the driving force behind all weather on the planet. Cold air sinks and warm air rises, this creates wind. Large amounts of air in this pattern, high in the atmosphere are referred to as jet streams. The jet streams move across the globe and are affected by the Coriolis Effect, so they do not move evenly.

Seminar Content

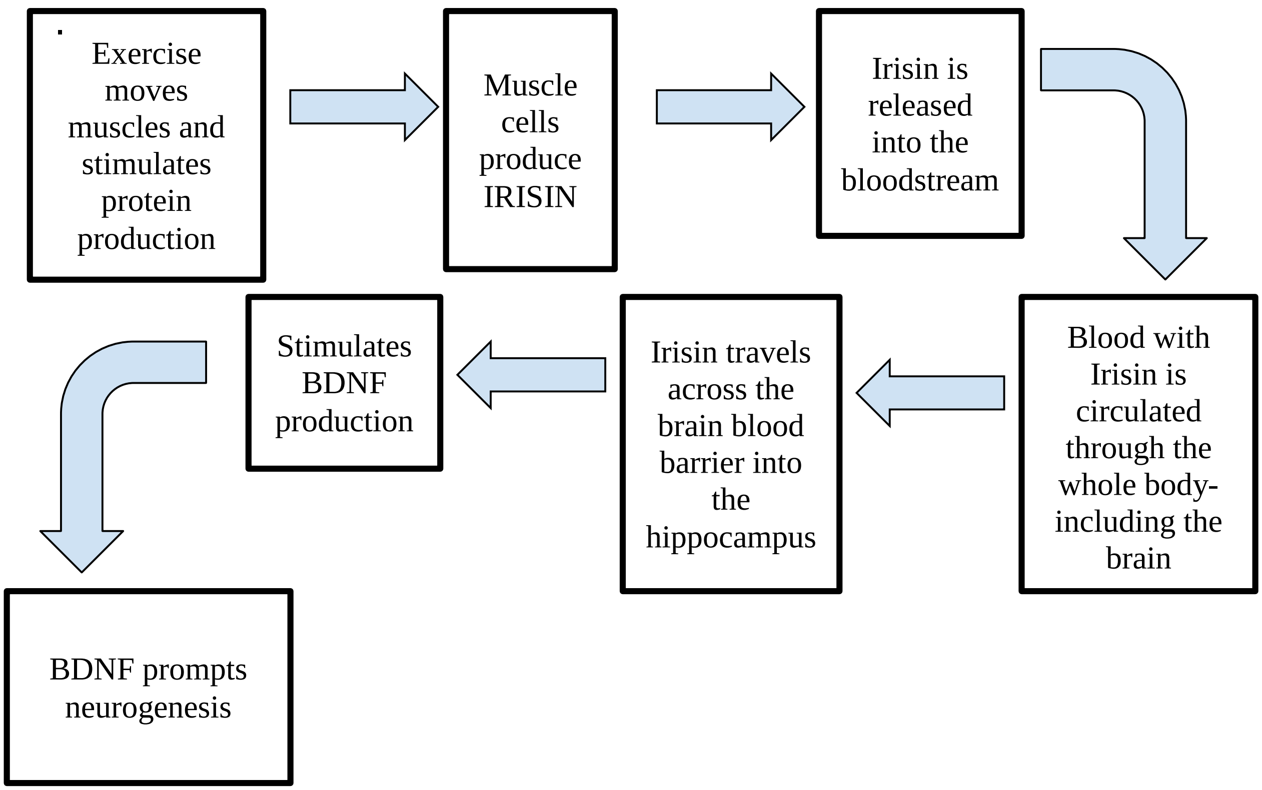
Brain Research

We have the amazing ability to change our brains (neuroplasticity) and help them to be more effective. Neurons are also known as nerve cells and are the building blocks of our brain. Neurons work together to receive information, interpret the information, and pass it along to the appropriate part of the brain and body. These messages come from our senses and can range from breathing, to walking, to solving a calculus problem. If you were to increase the number of neurons then more information could be passed to the brain and make the brain more effective. “Everything we do think or feel is governed by how our brain cells or neurons connect to one another” (2). As teachers, one way we want our students’ brains to be more effective is through memory. The more they remember the more success they will achieve. The most important part of the brain for memory is the hippocampus.

Scientists have discovered that when new neurons are generated there is a protein present, BDNF. This protein stimulates neurogenesis, the birth of new neurons. So it stands to reason that as teachers we would want our students to have more BDNF. When more cells are grown the neurons have more in their network to receive, interpret, and pass along information. It has been recently discovered that by moving or exercising BDNF production is enhanced (3).

Irisin

Your body creates proteins for all different functions. Irisin is a protein that has been linked to adult neurogenesis. The flowchart below shows how exercise produces the irisin tracks throughout your body to your brain (4).



Memory

Working memory is the process of the hippocampus receiving information, combining it with prior knowledge and processes so that one can form conclusions. According to Peter Doolittle (5), there are six strategies we need to be aware of in order to improve working memory:

1. Process the information immediately
2. Practice the information over time
3. Purposefully connect this with prior knowledge

4. Use imagery
5. Organize
6. Support

As teachers we can plan our lessons to aid in memory. To help process, we can encourage questions and conversation about the new material. To practice, they should retell the experience to a peer or write it in their science notebook. Connecting the new vocabulary with different situations allows the students to be connected. Specifically telling students to make a picture mentally or in notebooks builds the image. Providing real life examples organizes the new information and the memory is further supported by making an anchor chart using images and/or a graphic organizer with specific information from the activity for future reference.

A convenient byproduct of actively supporting the working memory is that it will prime the long-term memory, which is our ultimate goal: teaching students how to think for their entire lives not just this moment. All of which happens in the area of the brain where BDNF is produced by moving more. While BDNF is working, teachers can continue to boost the memory by assessing the students between activities (6).

Classroom Activities

Weather Forecasting and Tracking

Before beginning any of the formal lessons it is important to expose the class to weather forecasting and national maps. Take 5 -10 minutes a day to show the students the current weather map/ forecast and have casual conversation about their observations. This will prime their brain for future lessons. Possible topics of discussion: reading a precipitation map accurately (radar), understanding each of the columns on a 10 day forecast, and comparing the 10 day forecast from Monday to the 10 day forecast on Tuesday. It is important to stress that the weather forecast is a prediction based on the current numbers. Since weather is constantly changing, the numbers that meteorologists' use are also changing, this is why the ten day forecast can look different from one day to the next.

Molecules Move because of Heat Energy - 1

Engage

Show the students devices with no energy (no batteries, no electricity, etc.) Ask how can we make these move? How can we make them work? Plug in the device or add batteries and ask the students what happened. Why can't we put small batteries inside the toy? This should facilitate responses of - there is not enough energy. Once you have the students remembering that more energy = more work or movement start the explore section.

Explore

Have the students stand very still, near each other in a large space (bus parking lot). Tell them that when you hand them a piece of confetti they need to pretend that it is giving them energy to move around. The more confetti they receive the more they should move around and spread apart from other people. Place the confetti in a place that is higher than the students, you will transfer the energy from this location to them. The higher location will serve as representation of the sun.

Once they have demonstrated this concept effectively, add another element. As they are moving around with more "energy" when they come closer to another person with less energy they need to give them a piece of confetti. Remind them that now they have given away energy and should move slower but the other person should move faster. Have them continue exchanging "energy" for a few minutes.

Allow for reflection time, either conversation or written in science journals. Did you always have the same amount of energy? Why did you lose energy? How did you gain energy? Where was the energy located? Why do you think the energy was so high away? When you had more energy how did you behave? What happened to your behavior when you lost energy?

Explain

Heat is a form of energy. When molecules receive more heat they are gaining more energy. As the energy increases the molecules move faster and spread farther apart. This behavior happens specifically in air and water. In order to understand weather we need to understand air and water, the two pieces that make weather. Air receives its heat energy from the sun. Molecules with more heat energy give energy to molecules with less heat energy. Have the students do the activity again but this time with labels, air molecule and heat energy, the location of the energy is the sun and the teacher who hands out the energy is transferring the energy to the air molecules.

Elaborate

When there is room between molecules something needs to fill that space. Since the air molecules are moving around and spreading out water molecules fill up that extra space. Have a group of students act like cool air molecules and as the sun gives them more heat energy they have spread out enough to fit a "water molecule"/ a hula hoop. Have a non-air molecule student act as a water molecule and fill space between warm air molecules while holding up the hula hoop.

Have the students demonstrate this concept by adding more and more energy which will add more space to add more water molecules. Make connections to weather forecasting. When a group of water molecules collect in the air what do they create? Answer: clouds. What type of weather is more likely to happen if there are more water molecules in the air? Answer: cloudy/rain. So, when it rains are the air molecules closer together or farther apart? Answer: farther apart. These questions can also be helpful for evaluating their application of the water cycle.

Evaluate

Students will create a way to demonstrate how air molecules act when they receive energy and when energy is taken away.   Make sure to include air molecules, water molecules, heat energy and movement. They can write out an explanation, draw a picture, and/or create a flowchart.

Uneven Heating - 2

Engage/Explore

Remove chairs from around the tables/desks and give each team a bunch of gram pieces and have them pretend the pieces are air molecules. Have the students walk around the room exchanging air molecules by asking, “Can I have your air molecule?” This small amount of movement and vocabulary association will help create a memory.

Ask each team to demonstrate on their tables how cold and warm air molecules behave, by using the gram pieces. Connect vocabulary and content from previous activity. Count how many pieces they used for cold air and record the number to use later. Do the same with the warm air. Cold air molecules should be rather close together and they should use the gram pieces in high numbers. Warm air molecules should be completely spread apart and they should use significantly fewer pieces. What are we missing from our model from the previous lesson? Answer: water molecules. You can use something completely different to represent the water molecules but they are not to be used in the following activity.

Give each table a balance scale and labels - cold air and warm air - show what happens when you put the same number of cold air molecules from the table activity on one side of the balance and the number of warm air molecules on the other side. The cold air molecules push down and the warm air molecules rise up. Students should reflect in their science notebooks and with their teams. Reflection could include a picture with labels and numbers of both the table and balance scale. Have them continue to engage with this concept and label each side of the balance scale with cold air or warm air. Ask them how they can show with body movement how the cold air molecules act and how the warm air molecules act. Have students demonstrate and practice as a class.

Explain

The cups on either side of the balance scale are the same size, when you add more mass to one side there is more force to push the cup down, more pressure. Cold air has more mass because the molecules are close together so more air molecules can fit in the cup than in the warm air cup. This happens with air molecules everywhere, cold air sinks and warm air rises. When the balance scale has warm air and cold air the balance is uneven. When each side has the same type of air the scale is even. This uneven heating of the Earth is the cause of weather conditions.

The cold air molecules exert more pressure, and the warm air molecules exert less pressure. When warm air rises and cold air sinks. This is called convection current. It is important to continue to use the vocabulary word pressure and encourage your students to do the same.

Show your students a temperature map of the world and ask them where the air molecules have low pressure and high pressure. They should recognize the pattern of warm air surrounding the equator and cooler air towards the poles. How does the air from the equator behave? Answer: the air rises and spreads apart because it is less dense. How does the air around the poles behave? Answer: the air sinks because it is more dense.

Elaborate

Use a smoke box to show how the air moves when it is heated versus cooled (7). Students should discuss what they see. Warm air rises above the candle and cool air sinks away from the candle. The cold air pushes against the warm air - this creates wind. Due to the fact that wind is invisible it is important to give the students many opportunities to “see” wind. The smoke box is one of very few of these activities. Draw a picture of the smoke box for the class to see while you model proper labeling techniques. Label with more pressure, cold air, less pressure, warm air, rising air, sinking air, arrows to show movement and any other connections from previous lessons. Ask where in the smoke box would we label the equator and the poles? Answer: the equator is modeled with the candle and the poles are the other side of the box, away from the heat source. What can we add to the description of warm air molecules from the equator? Answer: As the air spreads out and away from the heat source it loses heat energy and sinks away from the equator. What can we add to the description of air molecules from the poles? Answer: As the air sinks it travels towards a heat source, the equator.

Take the class out to the playground and have them visualize the smoke box on the equipment. Ask them where they should place the bowl of heat energy. The bowl of heat energy is pretending to be the candle/ equator. Once the air molecules have more heat energy where should they travel? Answer: up the playground equipment. After they have travelled away from the heat source what will happen to their energy? Answer: the air molecules will lose heat energy and sink. Have students demonstrate this behavior by descending the equipment and returning to the heat source. This movement of air molecules, in a circle, is called a convection current. The convection current is responsible for moving weather around the planet.

Evaluate

Have students explain what is happening with the air molecules to create wind using the vocabulary of mass, molecules, pressure, rising, sinking, equator, poles, convection current, and uneven heating. They can choose to draw a diagram of actual weather on Earth, descriptive explanation or alternate way to display their knowledge.

Air Masses - 3

Engage

Using the gram pieces again choose warm air or cool air molecules to model on tables and have students push all the tables/desks together. Have students record this activity in their notebooks but only using the vocabulary of the air molecules, not the tables and gram pieces.

Have students demonstrate where they should sit if they were cold air molecules, under the tables because they are dense and sink, and warm air molecules, on the table because they are less dense and rise into the air.

Review how many molecules should be in a cold air mass versus a warm air mass: more in a cold air mass and less in a warm air mass. Which molecules have more pressure as a mass?

Cold air mass = High Pressure
Warm air mass = Low Pressure

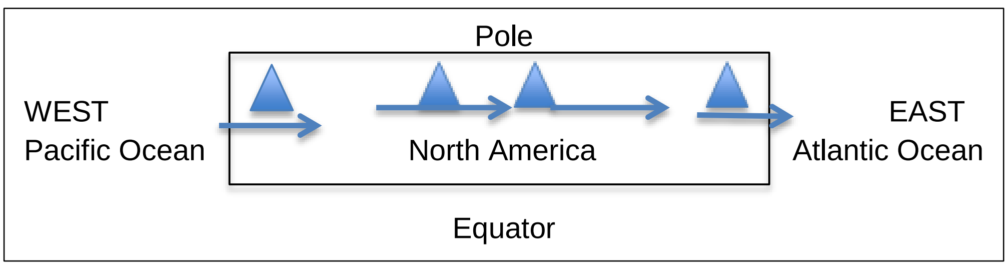
Prepare a long piece of string with the ends tied together and show the students how it is a large enough circle to fit all the tables, the whole air mass. Our next activity will have the students pretending to be the air molecules and traveling together as an air mass. The cold air mass will carry a large blue cut out of a capital H and the warm air mass will travel with a large red cut out of a capital L. Ask the class which type of air mass should have which letter and why. Students should record their answer with evidence to support their thinking.

Explore

Set up four or five cones in your large space with numbers on them. Spread them equally across your space. The numbers will be used as reference points for your students to draw the air masses. Have students determine the cardinal directions of the space using a compass. Label each direction for reference.

The game will begin in the west, because west is the best! The air masses will travel east until they reach the next "ocean", the land will be the bus parking lot and the oceans will be the grassy area on each side. The object is to be the first air mass to reach the east coast.

You will need three groups of children, high pressure group, low pressure group and meteorologists. There will be fewer members of the low pressure system because it is less dense, students will stand in the rope and spread apart, a few will hold the rope up, the students are not allowed to leave the rope, the air mass travels together. The high pressure group will need more students and they will travel much closer together in their rope. The meteorologists will stand to the north and south of the "ocean" and track the movement of the air masses in their notebooks as they move west to east.



The air masses are playing Red Light, Green Light, 1, 2, 3. One student, named "Prevailing Westerly", will stand in the ocean on the east coast and announce "red light, green light, 1, 2, 3", when they say red light the air masses can start moving across the land but by the time the announcer says "3" the whole mass must freeze. If the announcer turns around and sees them moving they must walk all the way across the land and around the world to make it back to the start, "west is best". If the air masses are still in play the meteorologists will draw the appropriate letter on their map, H or L. Continue to play until both air masses have travelled across the land. Play enough times for everyone to be in each group. After each game have the students reflect in their notebooks about their position.

What was your position?
What did that look like?
What did that feel like?
What was easy about your position and why?
What was difficult about your position and why?
What was your favorite position and why?

What position made the air masses move?
Describe how the air masses moved.

Explain

Air molecules with similar properties travel together. When these groups of molecules cover a space of hundreds to thousands of square miles they are air masses. Meteorologists watch how the air moves due to winds pushing them from West to East. In North America weather travels from the west to the east because of the winds named Prevailing Westerlies. Show students a current weather map with the pressure systems and show how their maps from the game resemble the real weather maps. If possible use a transparency of the United States to lay over their map from the game.

Elaborate and Evaluate

Show students a current weather map with the pressure systems and show how their maps from the game resemble the real weather maps. If possible use a transparency of the United States to lay over their map from the game. Have students discuss their observations. Listen for key vocabulary and patterns that they are observing. Ask students to predict the weather for a location on the map in one day, two days etc. They should justify their predictions by saying "the prevailing westerlies will push this low pressure system to the east and cause warmer temperatures with high humidity." Keep track of their predictions and verify the next day in class.

Further Extension

Play the game again. This time add more details to weather movement and properties of air masses. This time introduce warm air masses traveling from the south (near the equator) and cool air masses traveling from the north (from the pole). Air masses are separated by the jet stream. Instead of having students be the meteorologists, this time have the students make the jet stream. They will stay within a designated path and provide a barrier between warm and cool air. Change the path of the jet stream each time the game is played, have it dip down to the south and stay farther north. The air masses are not allowed to travel across the jet stream; they must stay on their side, to the north if they are cool and south if they are warm. The jet stream group can carry tissue paper above their heads as they travel along their track, to signify that jet streams are located high in the atmosphere and are streams of air, or large pieces of cloth to make a visual statement of a barrier. It is important for each child to play in each position again. Referencing the assessment, have the jet stream move north and south and discuss the changes in the weather.

Review Activities

Weather Forecasting

Tell students that they are planning for two different events. The first event is an outdoor kickball game with their friends. What kind of weather would you prefer for this event? The second event is a mud volleyball tournament. They need to prepare the court, the need to make a lot of mud. What kind of weather would be most helpful for this preparation?

Students can think to themselves and write their initial ideas down in their notebooks and then stand up. Once they have noticed another person standing they can walk to a place in the room and share their ideas. Encourage students to use 5^{th} grade vocabulary when describing weather conditions.

Vocabulary Relay Race

Students form teams to correctly define vocabulary words from the unit. In a large space the teams stand on one end while the vocabulary word is across the field. The first student runs to the vocabulary word, writes the definition to the word and runs back to their team to tag the next person to define a different vocabulary word. If at any time a student does not know the definition they can run back to their team to ask for help. They are not allowed to bring back paper or pencil; they must remember what their teammates have told them. They are allowed to run back as many times as needed. The first team to correctly define all words wins.

Vocabulary Graffiti

Hang large pieces of butcher board paper around the room or hallways. On each of the pieces write a different unit concept or vocabulary word – wind, pressure, weather, forecasting, convection etc. Provide markers, crayons and colored pencils and have the students rotate to each paper and write/draw their piece. Encourage the use to their notebooks.

Key Vocabulary

Air mass	Balance	Characteristics
Air pressure	Boundary	Cloud cover
Atlantic Ocean		Cold front
Atmosphere		Condensation
		Conditions
		Conduction
		Convection

Equator

Gulf Stream

High pressure

Jet Stream

Low pressure

Mild

Pacific Ocean
Pressure
Prevailing westerlies

Radiation
Rotate Clockwise

Trade Winds
Tropical

Uneven heating

Warm front
Weather
Weather conditions
Weather forecast
Weather system

Appendix 1: Implementing Teaching Standards

North Carolina Essential Standards

Essential Standard: Earth Systems and Processes

In Kindergarten students observe the weather throughout the entire year to develop an understanding of patterns in their natural world. The particular standard is K.E.1 Understand change and observable patterns of weather that occur from day to day and throughout the year. Daily opportunities are made for students to observe and record the weather and the changes that have occurred from one day to the next. Once a sufficient amount of data has been collected to reinforce weather concepts students can make comparisons throughout the year, including seasonal details.

Second grade provides the introduction to the causes of these weather patterns that were first observed in Kindergarten. The specific objective from the Essential Standards states 2.E.1 Understand patterns of weather and factors that affect weather. Students have opportunities to discover the impact the suns energy has on the land, air and water. Weather conditions are collected and summarized including temperatures, wind direction, wind speed and precipitation.

Students' final year in elementary school combines all of their past investigations of weather with their understanding of science concepts across the disciplines. The essential standard states in 5.E.1 Understand weather patterns and phenomena, making connections to the weather in a particular place and time. Students use their discoveries about energy and matter to improve their understanding of weather conditions. These understandings include global patterns of wind and water affecting temperature, wind direction and speed, and precipitation.

Appendix 2: Assessment (8)

1. Which is most responsible for the uneven heating of the air in the atmosphere?
   a. radiation
   b. convection
   c. conduction
   d. condensation

2. Which will most likely result from a low-pressure weather system?
   a. warm temperatures
   b. cloudy conditions
   c. clear conditions
   d. cool temperatures

3. Which is the best explanation for how air masses move across the United States?
   a. The prevailing westerlies move air masses from west to east across the United States but may be deflected by the jet stream.
   b. The trade winds move air masses from west to east across the United States.
   c. The jet stream moves air masses from the Pacific Ocean across the United States.
   d. The warm air of the Gulf Stream causes air masses to move from the Atlantic Ocean to the Pacific Ocean.

4. Which has the greatest effect on wind speed?
   a. precipitation
   b. cloud cover
   c. wind direction
   d. air pressure

5. On a cold, cloudy day, the local weather forecaster predicts that a high-pressure system will be moving into the area in the next 24 hours. Which weather conditions will this system most likely bring to the area?
   a. stormy
   b. sunny
   c. snowy
   d. hot

6. Which best describes a characteristic of the jet stream?
   a, It forms a boundary between a cold air mass and a warm air mass.
   b. It creates the high winds around the eye of the hurricane.
   c. It forces the hot air along the equator to rise to areas in North America.
   d. It causes high pressure air masses to rotate clockwise.

7. The weather forecast indicates that a warm front will be moving into the area in the next 24 hours. Which type of weather will most likely result?

a. clear skies and cold temperatures
b. clear skies and hot temperatures
c. cloudy skies and rainy weather
d. heavy snow and ice

8. What will most likely result when the jet stream moves south of North Carolina?

a. North Carolina will experience tropical weather conditions
b. North Carolina will experience hot, dry weather.
c. North Carolina will experience mild weather.
d. North Carolina will experience cold weather.

List of Materials for Classroom Use

Molecules Move because of Heat Energy – 1

"Confetti" – any small object that students can carry
Open space – bus parking lot
High location – playground equipment
Hula hoops – 8-10 depends on class size
Science notebooks

Uneven Heating – 2

"Confetti" – same from lesson 1
Tables/desks
Gram pieces – enough to cover each table
Balance Scales – one for each team
"Cold Air" and "Warm Air" labels
Smoke Box materials
Playground
Science notebooks

Air Masses – 3

Tables/desks
Gram Pieces
String/rope
Large blue "H" cutout
Large red "L" cutout
4-5 cones with numbers as reference points
Compass
"Equator" and "Pole" labels
Open Space – bus parking lot
Science Notebooks
Tissue paper or cloth

Reading List for Students

Breen, Mark, Kathleen Friestad, and Michael P. Kline. 2000. *The kids' book of weather forecasting: build a weather station, "read" the sky & make predictions with meteorologist Mark Breen and Kathleen Friestad ; illustrations by Michael Kline*. Charlotte, VT: Williamson Pub. This book provides hands on activities for students to try to develop their curiosity for weather forecasting.

Cosgrove, Brian. 2013. *Eyewitness weather*. London [England]: DK Pub. http://www.credoreference.com/book/dkewwea. This book is filled with photographs, charts and text to engage the reader.

Dorion, Christiane, and Beverley Young. 2011. *How the Weather Works*. Somerville, Mass.: Templar Books/Candlewick Press. This interactive book engages readers to discover weather processes and changes.

Dorros, Arthur. 1989. *Feel the wind*. New York: Crowell. This book helps to illustrate the effects wind has on weather and how wind is created.

Furgang, Kathy and Tim Samaras. 2012. *National Geographic Kids Everything Weather: Facts, Photos, and Fun that Will Blow You Away*. Washington, D.C.: National Geographic. This photograph rich book explains weather phenomena in a way that is interesting and engaging to all audiences.

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Endnotes

1. Klingberg, Torkel. 2013. *The learning brain: memory and brain development in children*. Oxford: Oxford University Press.
2. Servick, Kelly. 2013. "How Exercise Beefs Up the Brain". *Science Now*.
3. Wrann CD, JP White, J Salogiannnis, D Laznik-Bogoslavski, J Wu, D Ma, JD Lin, ME Greenberg, and BM Spiegelman. 2013.
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5. Films for the Humanities & Sciences (Firm), and Films Media Group. 2013. *TEDTalks Peter Doolittle - How your "working memory" makes sense of the world*. New York, N.Y.: Films Media Group.
6. Raine, Lauren B., Hyun Kyu Lee, Brian J. Saliba, Laura Chaddock-Heyman, Charles H. Hillman, and Arthur F. Kramer. 2013. *"The Influence of Childhood Aerobic Fitness on Learning and Memory". PLoS ONE. 8 (9).*
7. Biological Sciences Curriculum Study, and Kendall/Hunt Publishing Company. 1999. *BSCS science T.R.A.C.S.: an elementary school science program. [5]*. Dubuque, Iowa: Kendall/Hunt Pub. Co.
8. "North Carolina READY End-of-Grade Assessment Science." NC Public Schools. July 1, 2015. Accessed November 22, 2015. http://www.ncpublicschools.org/docs/accountability/testing/releasedforms/g5scipp.pdf. The Department of Instruction released sample questions from the 5th grade Science EOG. These are very helpful when prepping students for testing and help to guide lesson development.

Bibliography

Biological Sciences Curriculum Study, and Kendall/Hunt Publishing Company. 1999. *BSCS science T.R.A.C.S.: an elementary school science program. [5]*. Dubuque, Iowa: Kendall/Hunt Pub. Co. This is a research based curriculum unit that is easy to follow and implement in the classroom. Resources are provided to improve teaching methods for weather concepts. Literacy is implemented in many lessons.

Films for the Humanities & Sciences (Firm), and Films Media Group. 2013. *TEDTalks Peter Doolittle - How your "working memory" makes sense of the world*. New York, N.Y.: Films Media Group. This TED talk is brief and engaging about working memory. Peter Doolittle is an educational psychology professor concerned with understanding the process of learning.

Klingberg, Torkel. 2013. *The learning brain: memory and brain development in children*. Oxford: Oxford University Press. This introduction into neuroscience is a quick and easy read to help better understand the process of learning in the developing brain. There are case studies to support and provide background on how the brain most effectively creates long-term memory.

Raine, Lauren B., Hyun Kyu Lee, Brian J. Saliba, Laura Chaddock-Heyman, Charles H. Hillman, and Arthur F. Kramer. 2013. *"The Influence of Childhood Aerobic Fitness on Learning and Memory". PLoS ONE. 8 (9).* This study provides evidence to support that children with better fitness levels retain information better than their lower fitness level peers.

Ratey, John J., and Eric Hagerman. 2008. *Spark: the revolutionary new science of exercise and the brain*. New York: Little, Brown. This book logically explores the relationship between exercise and the brain. Even though it is written by a doctor it is easy to follow and the references to the case studies facilitate the explanation.

Servick, Kelly. 2013. "How Exercise Beefs Up the Brain". *Science Now.* This article explains the chemical evidence of protein development during exercise and these proteins are connected to neurogenesis.

Wrann CD, JP White, J Salogiannnis, D Laznik-Bogoslavski, J Wu, D Ma, JD Lin, ME Greenberg, and BM Spiegelman. 2013. *"Exercise induces hippocampal BDNF through a PGC-1α/FNDC5 pathway".* Cell Metabolism. 18(5): 649-59. This study identified irisin could stimulate BDNF in the brain.