Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2008 Volume V: Forces of Nature: Using Earth and Planetary Science for Teaching Physical Science

Matter in Motion

Curriculum Unit 08.05.01
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Introduction and Unit Goals

Earth science is an engaging topic, which I find motivates many reluctant readers. Children are fascinated by natural occurrences such as thunderstorms and volcanoes. In past years because of student interest, I have planned units on natural disasters. I began teaching these units only to find that my students lacked the background knowledge necessary to understand the driving forces that fuel the disasters. At that point I would back track and unsuccessfully try to fill in the gaps in their understanding. Upon reflecting on these shortcomings, I realized that I was approaching the unit backwards.

The following curriculum unit is designed for second graders. It is intended to help teachers gain content understanding and pedagogical methods to effectively teach students about matter and motion, as a means of building the background knowledge necessary to understand occurrences in nature. The unit focuses on presenting students with inquiry based science activities and experiments that build schema. The knowledge that the children will gain from these activities will directly support students in understanding the natural disasters and weather occurrences that they find so interesting.

Matter

In order for students to understand natural occurrences in their world, they must first understand the concept of matter. Matter in this context is defined as material substance that has mass and occupies space. (Trumbauer, 2007) In this portion of the unit, children will need to understand that matter can be present in our world in different states, matter is not created or destroyed, and that matter in different states behaves differently. (Abruscato, 2001)

Solids, liquids, and gasses of the same type of matter have the same molecules. What defines matter as solid, liquid or gas is the behavior of those molecules. Molecules in solid matter have a pattern that gives the solid a definite shape. This shape will not be changed unless acted upon by an external force. (Trumbauer, 2007) If you set a piece of paper on a table, alone it will not change shape; however, the piece of paper will change

shape if a child tears or crumples it. The molecules in a solid are tightly packed and there are only slight vibrations rather than fluid movement. This is what causes a solid to hold its shape. (Abruscato, 2001)

The shape of a liquid is easily changed and takes the shape of the container that holds it. In addition, all liquids can be poured. (Trumbauer, 2007) Children can see this example in their own lunches. If a child has a carton of milk, the milk takes the shape of the carton. If the milk is poured from a carton to a glass it changes shape to fit the glass. When the glass gets knocked over on the table, it will continue to expand and flatten until the surface tension causes it to stop spreading. In a liquid, molecules have more room to expand and flow within the confines of the liquid. The molecules are touching but move faster and more freely than in a solid, giving liquid it's flowing and formable properties.

Most gasses are invisible but they classify as matter because they have mass and take up space. This is evident when you think about the example of a balloon filled with air, or helium. When the balloon is filled with air, the air makes it expand and takes up the space within the balloon as it does with the helium. The air in the balloon has the same mass as the air surrounding the balloon, but the helium balloon rises because it has less mass than the surrounding air. Gas molecules move much faster and more freely than those of solids or liquids because they are not touching one another.

To demonstrate this to children, one could put marbles into a small bowl. If you put only a little energy into gently shaking the bowl back and forth, the marbles will be touching in the bowl and only move slightly back and forth while retaining their position in the bowl. This resembles the motion of the molecules within a solid. If you put more energy into shifting the bowl back and forth the marbles will shift back and forth in the bowl but they will continue to touch like a liquid. If you were to violently shake the bowl using even more energy, the marbles would break free from one another and spill out all over the room like the molecules within a gas.

Inquiry based lessons will give students crucial experience with matter. These experiences will be fundamental in preparing students to discuss phenomena that occur in nature. The experiments will help the students understand that matter can be present in our world in different states, matter is not created or destroyed, (Abruscato, 2001) and that matter in different states behaves differently.

Scope and Sequence

Day 1- Inquiry lesson- What is matter? -- The students need experience with matter in their own environment.

Day 2- Sort and discuss- What are the states of matter? -- Children sort different examples of matter.

Day 3- Introduction to molecules- model using magnetic marbles (see example above)

Day 4- Read or show United Streaming video The Magic School Bus Meets Molly Cule (see Student Resource list) .

Day 5- Investigatory lesson- How long does it take to pour? -- Children can explore and graph the viscosity of different liquids in order to develop a concrete understanding that liquids can be poured (this lesson is described in detail in the lesson plan titled: How long Does it Take to Pour?).

Day 6- Investigatory lesson- Do gasses have weight and take up space? The teacher can tie a balloon full of helium to one end of a ruler and a balloon full of air to the other end of the ruler. Then the teacher can balance the ruler on his or her finger and let the children observe which balloon weighs more.

Matter in Motion

In order for children to understand natural occurrences in our world, they first must understand how matter moves. The forces addressed in this unit have been strategically chosen to support students' learning about natural disasters and occurrences. Buildup and release of stress and pressure is what fuels volcanic eruptions and earthquakes; friction causes some earthquakes; heat energy moves the water cycle, thunder storms, and hurricanes; and convection plays a big part in thunderstorms and hurricanes, and causes cold heavy tectonic plates to sink into the warmer viscous mantle. The lessons in this portion of the unit should be the foundation for learning.

State Changes

Heat is a type of energy and causes state changes in matter. When a solid is heated, energy in the form of heat raises the temperature of the solid causing the molecules to vibrate more quickly. The increased motion of the molecules causes them to break out of the pattern and eventually melt into a liquid. Upon heating the liquid further, the molecules move even more rapidly and the liquid begins to go through convection. The hottest liquid collects on the top and the quickly moving molecules escape in the form of gas. (Abruscato, 2001)

Stress and Pressure

In second grade, many crayons fall victim to children with less than perfect fine motor skills and crack under the pressure. When enough force is applied to the crayon, it can no longer support the pressure and snaps at its weakest point. Solid matter can be bent to a certain point but given enough stress it will break.

Friction

Newton's first law of motion states that "An object in motion will remain in motion unless a force acts upon it to stop or change it." (Trumbauer, 2008) If you were to putt a golf ball with a club and put it into motion and it did not hit anything, would it keep going? Of course not! The friction of the grass, the air and other environmental factors against the golf ball would slow it to a stop. Friction occurs when the surface of two objects move over one another, causing it to be a little more difficult for the object in motion to move. (Trumbauer, 2008)

Scope and Sequence

Day 1- Think and discuss- Put a matchbox car flat on a table and ask the children why it will not move. Then allow children to work in groups to list things that move, and what makes them move.

Day 2- Model the evaporation and condensation of water. Focus on the force that makes the water move.

Day 3- Read, or show the United Streaming video of The Magic School Bus Wet All over: a Book about the Water Cycle (see Student Resource list for more information).

Day 4- Investigatory experiment: Break, Bounce, or Deform? -- Children can be allowed to manipulate different types of matter to discover how it reacts when it is acted upon by an outside force. (this lesson is described in

detail in the lesson plan titled Break, Bounce, or Deform?).

Natural Occurrences of Matter in Motion

In this part of the unit, the students will be applying what they have learned about matter in motion to the natural world. Children will get a brief glimpse of different natural disasters and occurrences through shared reading, and will be allowed to choose one to research further and report on. This part of the unit will be highly differentiated for the varied abilities and interests in your class. Each student will be working at his or her own level on a topic of his or her own choosing.

In the section titled Student Resource List, is a list of quality children's literature and other resources to pique students' interest in such topics as rain storms, hurricanes, tornadoes, earthquakes, and the water cycle. Each day during reading time, the teacher should spend 15-20 minutes highlighting a specific natural phenomenon. In the section below there is content area knowledge for teachers regarding few common occurrences that may be of interest to students.

This part of the unit is an excellent opportunity to teach the children how to strategically read nonfiction texts. Nonfiction is different from fiction and must be approached differently. Start by reviewing the differences between fiction and nonfiction. This can be done by working together as a class and using a Venn diagram to highlight the similarities and differences. (Miller, 2002) Teach the children to pre-read by using the table of contents, headings, photographs, and diagrams to make predictions about what they will learn and to ask questions to set a purpose for reading. (See questioning lesson for more information)

Content Knowledge for Teachers

The Hydrologic Cycle

The hydrologic cycle is the system through which our planet's water is circulated. This is an excellent natural example of state changes of matter that children can research and see first hand examples in their own backyards. The driving force behind the water cycle is the sun's heat. As the sun heats the earth, the temperatures of large bodies of water begin to rise. As the temperature increases some of the water escapes as vapor through evaporation. The water vapor is less dense than the air and rises up through convection and upwelling warm air currents. The vapor rises until it reaches a point in the atmosphere at which it can cool and condense. Through condensation, the water returns to the liquid form as small droplets. When the droplets form groupings large enough to see, clouds are formed. Eventually, the droplets become too heavy to be supported, precipitation falls, and the cycle continues. The hydrologic cycle also includes erosion, flooding, and the reshaping of the earth's landscape.

Thunderstorms

Air masses with different temperatures and moisture contents are separated by fronts. A front is "A sloping surface separating air masses." (Abbott, 2004) When a cold front moves in, the cold dense air traveling along the earth's surface wedges warmer air up into the atmosphere. As the quickly rising warm air cools it forms clouds; however, as the air rises, it remains warmer and less dense than the surrounding air making the whole

system unstable. (USA Today, 2008) As more and more warm moist air rises in a storm system, electrical charges build inside the clouds. Particles with opposite charges are collected on the ground, and as the charges build, the attraction grows stronger and despite the air's tendency to resist electrical flow, the charges eventually come towards each other completing the electrical circuit when they connect. It is then that the charge from the ground flashes upwards. This is the flash we see in a storm. (USA Today, 2008)

Earthquakes

There are three different types of earthquakes: subduction zone earthquakes, transform fault earthquakes, and spreading center earthquakes. (Abbott, 2004) All three types of earthquakes are caused by tectonic crustal plate movement. An earthquake is an example of what happens to matter when it is acted upon by an outside force: the pressure built up by mantle convection and crustal movement.

The world's largest earthquakes are subduction zone earthquakes. These earthquakes occur when one crustal plate becomes cold and dense and begins to sink underneath another plate into the mantle because of convection. Stress is built up as the slowly sinking plate pushes back down towards the mantle. Eventually, the overriding plate snaps because of the pressure. The quakes cause deformation, and breaking of the crust. (Abbott, 2004)

Spreading center earthquakes happen in places where two plates are moving away from one another. These earthquakes are smaller and more frequent than subduction zone earthquakes. Because the hot rock in these spreading centers do not support stress well. (Abbott, 2004)

San Francisco's earthquakes are due to its location atop a transform fault. Transform faults move past each other in opposite directions. Friction between the two plates builds up stress. Some of the stress is released when the plates shift and cause earthquakes. (Abbott, 2004)

Volcanoes

The earth below our feet is constantly moving and changing. The interior of the earth is made up of layers: the crust, the mantle, and the core. The earth's surface is constantly cooling to space. The hot viscous mantle convects, and mantle rising near the surface can melt and produce magma. The pressure builds beneath the earth's surface until the cold brittle crust begins to crack, sometimes causing small volcanic related earthquakes. (Abbott, 2004) When the pressure is too much to be contained by the crust, a volcano explodes with a force that is directly proportionate to the amount of pressure that has built up.

Proportionally smaller amounts of pressure will cause slow flowing lava exemplified in the volcanic activity in Hawaii. In this type of eruption, the pressure is often being released, and consequentially does not have time to build up enough to cause an explosive event. Because of the low viscosity of the basalt magma water is easily able to escape in the form of a gas: steam. The matter being emitted from the volcano is in a liquid state and flows out onto the ocean floor, or land mass surrounding it, where it cools and becomes solid. (Abbott, 2004)

Large amounts of pressure cause explosive volcanoes similar to the Mt. Vesuvius eruptions. In these volcanic eruptions the pressure builds up over a long period of time and when the crust above can no longer support the pressure, it blows its top. These volcanoes are also so explosive because of the high viscosity of the matter being emitted. The rhyolitic magma is less fluid than the more common basalt magma, and the result is gas that has a more difficult time escaping. When the gasses can not escape, they expand in volume and

then explode. The matter in these types of explosions is present in the form of highly viscous liquid magma, exploding gasses escaping from the magma, and solid rock that is often broken from the crust in the violent explosion. (Abbott, 2004)

Lessons

Break, Bounce, or Deform?

Focus and Objectives: Children will be allowed to experiment with different types of matter in order to discover that with force, they can me moved and changed in different ways. In addition, they will recognize that by changing the amount of force applied to some types of matter, they can change how it reacts.

Materials: Lasagna (uncooked); butter; rubber eraser; molding clay; putty; cornstarch and water mixture; tools for manipulating solids may include: plastic tooth picks, safety scissors, plastic knives or spoons, a hammer or block; chart paper and markers for each group.

Procedure:

1. The teacher will introduce the lesson by showing the children the lasagna, butter, and rubber eraser. The teacher will facilitate a short discussion about what the objects have in common. If the students do not come up with it on their own, the teacher will point out that all three are matter.
2. The teacher will ask the students, “What do you think will happen when I try to smash these materials with this hammer/block?” The teacher will then record the students’ predictions on the board.
3. The teacher will hit each type of matter with the hammer or block and compare the results to the students’ predictions. The teacher will then introduce the vocabulary words break, bounce, and deform and apply the words to the results (The eraser bounced, the lasagna broke, and the butter deformed).
4. Distribute the putty, molding clay, and cornstarch and water mixture to the children and allow some time for free exploration and play. Then, call the children together and ask them to perform various tests on the materials to see if it bounces, breaks, or deforms.
5. Distribute one testing chart to each group (see appendix I); and allow them to complete the activity.

Conclusion: Conclude the lesson by having students share their results and guide them to the conclusion that

sometimes you can control what happens to matter by acting on it in different ways.

How Long Does it Take to Pour?

Focus and Objectives: Children will be allowed to experiment with different liquids in order to discover that different liquids have different viscosities and flow at a different rate. During this lesson, the children will synthesize information, in order to sort and graph the relative viscosity of different liquids.

Prerequisite: Some experience with time is necessary for this activity.

Materials: Liquids of varying viscosity can include: water, milk, maple syrup, molasses, honey; one additional container for each liquid; activity direction sheet (see appendix II); viscosity graphing chart (see appendix II); a stopwatch for each group or a clock with a second hand.

Vocabulary: Viscosity, viscous, liquid, flow

Procedure:

1. Ask the children what they know about liquids and facilitate a short discussion about the properties of liquids.
2. If it is not mentioned, point out the fact that all liquids can be poured and tell students that scientists have a word for the thickness or stickiness of a liquid- viscosity. Liquids that are very viscous are thick and sticky. Liquids that are less viscous are not as thick.
3. Introduce the activity by distributing the liquids to the groups and allowing the students to make observations. When interacting with the students, it is important to prompt them by modeling appropriate use of the vocabulary words.
4. Distribute the materials and read through the activity directions with the children.
5. Elicit predictions for the outcome of the experiment: “Which liquid do you think will take the longest to pour and will be the most viscous?” “Which liquid will flow the fastest and be the least viscous?”
6. Monitor the students while they engage in the experiment in small groups.
7. Post all of the completed graphs in the meeting area for a culminating discussion about the results.

Conclusion: The following things may be discussed in the conclusion of the lesson: Which liquids were the

most viscous, and how do you know? Which liquids were the least viscous and, how do you know? Did some liquids have similar viscosities?

Questions Lesson

Focus and Objectives: Students will learn how to use questioning as a reading comprehension strategy before reading.

Materials: Sticky notes, any one of the big books from the Student Resource List.

Procedure:

1. Tell the students the title of the book that you will be reading and model your thinking. For example, “This book is called *Volcanoes* , I am wondering what types of volcanoes the author will teach us about in this book.”
2. Tell the students that good readers always ask questions before, during, and after reading to help themselves learn more about a topic.
3. Model for students how to ask questions based on the title, and write your questions on sticky notes.
4. Use the table of contents or headings to model asking more specific questions about each section of the book and write the questions on sticky notes.
5. Sort the questions using a chart with columns labeled important questions, unimportant questions, and not questions at all.

Note: Allow students to interject their own questions as they feel comfortable doing so.

Conclusion: Ask students, “What makes a good question?” Facilitate a short concluding discussion, and instruct students to practice asking questions while they are reading independently.

Questions Lesson Part II

Focus and Objectives: Students will learn how to use questioning as a reading comprehension strategy before reading.

Materials: Sticky notes and chart from Questions Lesson Part I, the big books from the Student Resource List that was used in Questions Lesson Part I.

Procedure:

1. Remind students of the questions they sorted the previous day.

2. Model using the table of contents, index and book illustrations to find the answer to one of the questions. Stick the sticky note to the page with the answer.
3. Encourage students to participate by helping you locate the answers.

Conclusion: Facilitate a discussion prompting students with the question, “How do text features help us find the answers to our questions?” and, “Why does asking questions help us to be better readers?” Instruct students to practice finding answers to their own questions in their independent reading.

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Appendix I

Bounce, Break, or Deform?

Names:_____

Date:_____

Material:_____

Try to roll it into a ball. What happens?

_____

Hit it with your fist. What happens?

_____

Try to stretch it. What happens?

_____

Place it on your hand and let it sit there for a full minute. What happens?

_____

Try to bounce it. What happens?

_____

Poke it slowly with your finger. What happens?

_____

Poke it quickly with your finger, what happens?

_____

Appendix II

How Long Does It Take to Pour?
Viscosity Graphing Sheet

Names:_____

Date:_____

	1 second or less	2 seconds	3 seconds	4 seconds	5 seconds	6 seconds	7 seconds or more
Water							
Milk							
Syrup							
Molasses							
Honey							

Appendix III- Content Standards

The topics and lessons in this unit relate to the following New Haven science content standards.

Performance Standard 1.2: Students will understand the process of scientific inquiry.

Performance Standard 2.3: Students will understand the fundamental concepts of the transfer of energy.

Performance Standard 6.4: Students will recognize fundamental concepts about changes in the environment and the effects of environmental change on the earth and its resources.