What Will Make a Rock Change?

Eilisha Joy Bryson
Science
Meredith School
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1. GUIDING INFORMATION:

a. Student and Classroom Characteristics

The students who took this pre-assessment are from Meredith School, a public school in the School District of Philadelphia. These students are in my 8th grade, self-contained classroom. There are 25 students in the class mixed with Caucasians and African-Americans. The girls out number the boys 14 to 10. In terms of economic status, Meredith does not qualify to receive free lunches for the entire school, and most students either do not qualify or never fill out the paperwork to receive free lunch. The school, as a whole has made adequate yearly progress, and is often commended for high standardized testing results. All but two students in my class are reading on grade level. Despite this, students are not receiving straight A's in my class. The students are well behaved, but are still pre-adolescents.

The group generally prefers Science to Social Studies, but do not have many opportunities to have meaningful, worthwhile science class. Much of the focus is spent on Reading, Language Arts, and Mathematics despite the fact that science is scheduled daily. The students do perform well on science written tests, but are not very familiar with science processes and effective scientific practices. In terms of group dynamics, the students are very talkative during group or independent work time. They definitely work better individually when they are far apart from one another. The classroom is arranged for group collaborations and large class discussions; there are 5 large tables used as student desks that can hold up to 6 students. Students are always expected to think critically and respond to their work on an 8th grade level, but they do not always comply. They are very inconsistent in their interests and work habits.

b. Prior Knowledge

Research shows that children have misconceptions about rocks and the rock cycle. The textbook, Inside the Restless Earth (2007), stated that students tend to believe that rocks can only change into one other type of rock, when they can actually change into *any* other type of rock. Heat can change a rock, but students often equate temperature and heat, not realizing that there is a difference. Just because a rock is heated does not mean that the temperature will continue to increase. This comes into play when talking about igneous and metamorphic rocks. Students may not know that a rock cycle takes millions of years to complete. LEARN (2004), a website for teachers that aligns activities with standards, states that children have problems rationalizing such a long period of time. Students believe, "The earth was always as it is now, or that any changes that have occurred must have been sudden and comprehensive." The following ideas are ones students believe about rocks, specifically:

> Rocks are associated with heaviness. Small rock fragments are stones, not rocks (Ex: a small piece of pumice would not be considered a rock). Mountains are associated with high rocks. Soil is the precursor of rocks. It changes from soil to clay to rock. Minerals are the same as rocks only they are precious rocks.

The School District of Philadelphia's Core Curriculum (2004) stated that students might need additional clarification on the differences and similarities between rocks and minerals. Students use them as if they are synonyms, but further attention is needed to explain that minerals make rocks.

The students were given open-ended questions as a pre-assessment to gauge their knowledge of the Rock Cycle and to test some of the misconceptions. In the assessment, students had to fill in a blank rock cycle diagram with the processes that explain how one type of rock changes into another type of rock. They were also asked to tell as much as they could about each step of the rock cycle. I also asked the students to tell how long it takes a rock to change shape. Students' prior knowledge about the rock cycle and how rocks change was almost non-existent. Many had not heard of the rock cycle before, and based on their response, they do not understand its steps. Students were unable to correctly label the process within the cycle. They were aware that magma was connected with heating. One student knew that it takes rocks millions of years to complete the cycle- everyone else thought it took a few months or a few years. This was a known misconception that people have. Their responses helped me determine what goals I needed to focus on in the lessons. My students need to learn about the processes that rocks go through, and they need to understand that one rock can change into another type of rock because of those processes.

2. PURPOSES:

a. Major Concepts

The rock cycle is a key idea in understanding the history of the Earth in terms of how it took its form, and how it continues to change.

Integrated Science (2007), defined rocks in a logical way. "Elements are *chemically* combined to make minerals. Minerals are *physically* combined to make rocks. A rock is defined as an aggregation of one or more minerals and perhaps other materials that have been brought together into a cohesive solid" (p. 280). There are three different types of rocks- igneous, sedimentary, and metamorphic- based on the different ways in which rocks are formed. Rocks are constantly changing, and they go through a cycle. The different processes that change a rock's form are: erosion, deposition, heat, pressure, lithification (compaction and cementation), and cooling and crystallization. How these processes actually change a rock is described further below.

The purpose of studying the rock cycle has to do with learning about the earth's formation. The rocks reveal information about minerals and resources that are found in certain areas of the earth. By interpreting the structure of rocks, it can reveal information about the events in earth's history. Knowing about the rock and rock structures also provides insight into how the earth came to look the way it does now, and how and why it changes.

All rocks, according to Integrated Science (2007), were said to once have been igneous. The name igneous actually comes from the Latin word *ignis*, or fire, because igneous rocks begin as magma, "melted rock material" and become rock after the magma has cooled and solidified (p. 280). The following information is necessary because it explains how igneous rocks are formed, but it also explains how rocks are able to change from one type into another type. The magma that forms the igneous rock is actually made from rocks- any type of rock- metamorphic, sedimentary, or even igneous. It is important to understand this process because it illustrates how rocks can change, which is the whole basis of the rock cycle.

Inside the Restless Earth (2007) states that the magma that creates igneous rocks can form in three ways, all of which involve melting rock. Magma will form when rocks are heated to temperatures that cause some or all of the minerals within the rock to reach their melting points. The melting point of rocks can change when its chemical composition changes. This happens if other elements combine with the rock, and magma then forms. The final way magma forms is when rocks melt because they have less pressure on them. Higher levels of pressure, from being deep within the Earth, cause the minerals within rocks to remain as solids. When the rocks rise to fewer depths, the pressure is released and the minerals can melt, thereby forming magma.

Another rock that can form as rocks get recycled through the rock cycle is sedimentary rock. This type of rock is formed from dissolved, eroded pieces of metamorphic, igneous, other sedimentary rocks, or from dead sea creatures. Water ice, heat, and wind erode the elements and the pieces, or sediments, are carried away. The sediment forms on the Earth's surface in layers, many of which are on the bottoms of seas. These fragments alone do not create rocks. In order for the sediment to join together two things must happen. The explanation of this is explained well in the Inside the Restless Earth (2007) textbook.

> As new layers of sediment are deposited, they cover older layers. Older layers become compacted. Dissolved minerals, such as calcite and quartz, separate from water that passes through the sediment to form a natural cement that binds the rocks and mineral fragments together into sedimentary rock. (p. 40)

Once the bonding has occurred, the International Encyclopedia of Science and Technology (1998), says that the Earth can move causing the sediments to "uplift … and tilt, fold, or fault" thereby creating the sedimentary rock (p.318). One distinguishing feature of sedimentary rock is its visible layers, or strata.

The last type of rock is metamorphic rock. It takes its name, as Inside the Restless Earth (2007) notes, from two Latin words, *meta* (meaning change) and *morphos* (meaning shape). A metamorphic rock is one that has changed its shape or chemical composition in a "distinctly different" way (Integrated Science, p. 282). Heat and pressure are the two factors that can cause such a change: heat and pressure. The heat comes from the magma, either through direct or indirect contact. Pressure can come from movements of the Earth. The heat and pressure interact with a pre-existing rock and alter its shape or mineral alignment. These behaviors are similar to those that cause rocks to melt into magma and cool into igneous rock, but they are slightly different. The pressure and heat are not enough to melt the rock, just change its solid form. This is the final way rock can change in the rock cycle.

The International Encyclopedia of Science and Technology (1998) and Inside the Restless Earth (2007) note that there are two important characteristics that all rocks have. One is the texture of the rock. For igneous rocks, that is determined by the location and rate in which the magma cools. A rock's texture is "coarse, medium, or fine-grained" (Inside the Restless Earth). Fine-grained igneous rocks, for example, will have small or no crystals. This happens when magma cools quickly on the Earth's surface, not allowing enough time for crystals to form. Igneous rocks that are formed under the Earth's surface, where temperatures are hotter, will cool at a slower rate. The large crystals will have time to take shape, causing the igneous rock to be coarser. The other characteristic is the chemical makeup of the rock, or its composition.

b. Learning Goals

The students will conduct labs that model the rock cycle. They will make connections between what they will be doing in the lab to what actually happens to rocks on Earth.

c. Objectives

1. Students will be able to describe four processes that shape Earth's features: erosion, deposition, heat, pressure, lithification (compaction and cementation), and cooling and crystallization
2. Students will be able to describe how each type of rock changes into another type as it moves through the rock cycle.

d. State Standards

PA State Standards:

Unifying Themes:

3.1.10 E Describe patterns of change in nature, physical, and man-made systems.

Earth Science:

3.5.10 A Relate Earth features and processes that change the Earth.

The National Science Education Standards:

Earth and Space Science-

Science Content D - students should have knowledge of the "structure of the earth system"

- Students can investigate the water and rock cycles as introductory examples of geophysical and geochemical cycles.
- Some changes within the solid earth can be described as the "rock cycle." Old rocks at the earth's surface weather, forming sediments that are buried, then compacted, heated, and often recrystallized into new rock. Eventually, those new rocks may be brought to the surface by the forces that drive plate motions, and the rock cycle continues.

The Benchmarks (grades 6 to 8):

- Sedimentary rock buried deep enough may be reformed by pressure and heat, perhaps melting and re-crystallizing into different kinds of rock. These re-formed rock layers may be forced up again to become land surface and even mountains. Subsequently, this new rock too will erode. Rock bears evidence of the minerals, temperatures, and forces that created it.

3. RATIONALE:

My plans for these lessons are for students to gain a deeper understanding of the rock cycle than a diagram in the book could offer. The lessons below are labs that model the processes that rocks go through. They provide students with hands on models so that students can explore the process and get exposure to the content. They have to learn about the processes because without them the rock cycle would not make sense. Once the students get to witness the processes happening before them, they will better understand what takes place in the rock cycle. They will revisit those concepts later in the text. These are the beginning lessons on the unit about rocks, so more lessons will be planned

4. CLASSROOM PREPARATION:

a. Instructional Materials
Bellringer Transparencies (Warm-up questions)
Materials for the lab (see lab sheets)

b. Management and grouping patterns
On each day, students will work in groups of 4 to complete the labs.

c. Safety
Safety is a concern on each day. On each day, students must demonstrate proper care while working with the science materials. , The labs require use of a hot plate. Students are to wear protective goggles, heat-resistant gloves, and must demonstrate care while working with hot materials.

5. TEACHING METHOD(S), INSTRUCTIONAL PROCEDURES, AND LEARNING ACTIVITIES:

Day 1

a. Phase of Inquiry:
Engage
Explore

b. Content
On this first day, students will model the rock cycle to get a better understanding of the processes involved in changing rock from one form into another.

c. Motivational opening
Students will do a think-pair-share based on the following prompt: *List and give a brief description of anything you know that goes through a cycle.* Students should *think* and record their own thoughts, and, after directed, *pair* up with their tablemates to discuss their ideas. The teacher will then ask the tables to share their findings with the entire class. She will record their ideas on chart paper. After that, the teacher will ask all of the students to jot down their thoughts when they hear the term "recycle". Ask a few students to share their thoughts with the class. The teacher will emphasize that they will be studying one of nature's cycles- The Rock Cycle- and give the standards and objectives for the lesson. The teacher will then distribute rock samples to each group and allow students to observe and "play" with them.

d. Core Learning Activities
Students will complete the "performance-based lab" (see lab sheet) in which students use sugar cubes to represent rocks. The sugar goes through heating and cooling, and at each stage can be equated to sedimentary, magma, igneous rock, and metamorphic rock.

e. Critical Questions
The analysis questions, numbers six through ten, elicit students to make the connections between what they observed in the lab to what happens during the Rock Cycle. (See Performance –Based Assessment lab sheet)

f. Closure
At the end of day one, the teacher will review what happened in the lab, discussing the similarities and differences of the processes the sugar went through and those that rocks go through.

Day 2

a. Phase of Inquiry
Engage
Explore

b. Content
Students will use clay to model the process of pressure in forming metamorphic rocks.

c. Motivational opening
Once students are in their lab groups, display the "Bellringer" (See Bellringer: Section: Metamorphic Rock) and ask students to respond to it in their science notebooks. The Bellringer asks students to compare sedimentary rocks with cookie dough and describe what happens when it metamorphoses in an oven.

d. Core Learning Activities
Students will complete the "Metamorphic Mash" Lab (see lab sheet) in which students use clay to model pressure. The students will observe the layering behaviors of the materials used.

e. Critical Questions
The analysis questions, numbers one through six, elicit students to make the connections between what they observed in the lab to what happens during the Rock Cycle, specifically metamorphic rocks (See "Metamorphic" lab sheet)

f. Closure
At the end of day two, the teacher will review what happened in the lab, discussing the similarities and differences of the processes they observed and what happens with metamorphic rock.

Day 3

a. Phase of Inquiry

Engage
Explore

b. Content
On this day, students will demonstrate heating and cooling and how the rate of cooling effects the size of crystals in igneous rocks.

c. Motivational opening
Show students pictures and descriptions of the Hawaiian Islands and the Rock Mountains. Students should then discuss the similarities and differences. Then pose the "Bellringer" (See Bellringer: Section: Igneous Rock) question and ask students to record their answers in their science notebooks. The Bellringer asks students to think if there is a difference between rocks that solidify from magma inside the Earth compared to on the Earth's surface.

d. Core Learning Activities
Students will complete the "Crystal Growth" Lab (see lab sheet) in which students use magnesium sulfate to model the crystallization processes at different rates of cooling. The students will observe three different rocks, and compare their results to those rocks.

e. Critical Questions
The analysis questions, numbers one through five, elicit students to make the connections between what they observed in the lab to what happens during the Rock Cycle, specifically igneous rocks (See Crystal Growth lab sheet)

f. Closure
At the end of day three, the teacher will review what happened in the lab, discussing the similarities and differences of the processes they observed and what happens with igneous rock.

6. EVALUATION STRATEGIES
The rubric used in the Performance-Based Assessment Lab will be used for each lab conducted during the three days. (See Performance-Based Assessment) This rubric grades the students on handling materials and equipment, their observations, and the analysis of their observations.

7. REFLECTION:
[leave blank - to be completed after instruction. This is your reflective presentation in the final week of classes]

8. ATTACHMENTS:

Rock Cycle References
Performance-Based Assessment (Teacher's Notes, Rubric, Blackline master and Answer Key)
Metamorphic Mash (Teacher's Notes, Rubric, Blackline master and Answer Key)

Crystal Growth (Teacher's Notes, Rubric, Blackline master and Answer Key)