Volcanoes and Their Impact on Humans

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INTRODUCTION

When I began to contemplate the direction I was going to take with my curriculum unit, I found my starting place to be with my own particular students. I am a Special Education teacher at Looscan Elementary in Houston, Texas. I teach reading, math and writing to children with specific learning disabilities and other health issues (like ADHD and anxiety disorders) that negatively affect their ability to learn. My students are between the ages of 7 and 12 (mostly boys). Many of my students come to me after having experienced failure and frustration in General Education classes for some years. Their self-esteem is often low, and they are not interested in much of anything that is going on in their homeroom classes. Thus, my classroom must be a place that sparks their imagination, their interest and their attention, sometimes for the first time in their lives. I have to do all of this at the same time I am trying to fill in the gaps of specific academic skills they are lacking.

Many of my students are also ELL's (English Language Learners). This means that English is not their primary language. Some of my students are only recently transitioned from a Bilingual classroom. For some of my students this creates a "double whammy" situation. They are struggling with specific learning disabilities or other health issues that negatively affect their ability to learn, *and* at the same time they are learning a second language. These two situations together can cause frustration, low self-esteem and failure for some students. When teaching these students, I must wear two hats. Under one hat I am the Special Education teacher using all of the strategies and modifications needed to successfully teach students with disabilities. Under the other hat I am the ESL (English as a Second Language) teacher using all of the strategies and modifications needed to teach students learning a new language. Fortunately, many of the strategies and modifications used for teaching students with disabilities and those used for teaching ELL's are the same. For example, one strategy common to both situations is that of using visuals or concrete examples to accompany oral or written instruction. Therefore, when introducing new vocabulary or concepts in this curriculum unit, I will use as many concrete examples as possible.

With all of these challenges in mind, I wanted to choose a topic for my curriculum unit that would grab my students' attention as well as teach them something about the world they did not already know. Many of my students have never been outside of Harris County. Their understanding of geography and the world around them is very limited. Thus, I wanted to introduce a topic that would expand their worldview. A topic that would introduce them to parts of the world they might never see in person. I want my students to understand that the world is an enormous and exciting place that extends past their own neighborhoods. Therefore, I chose to introduce the topic of volcanoes. I chose this topic for my curriculum unit because it will give my students the opportunity to explore different parts of the world. It will also give them the opportunity to explore the wondrous machine that is the planet Earth. Also, my students seem to be fascinated by things that blow up! Last year, I introduced the topic of volcanoes in the form of reading comprehension activities. To my delight, my students responded in a way I did not expect. They were excited by the information they were reading! Thus, I believe the curriculum

unit I am developing will take this initial spark of interest and turn it into an inferno of interest and participation for my students.

The curriculum unit I am developing is entitled "Volcanoes and Their Impact on Humans." This curriculum unit will be divided into three different sections. The first section will answer several different questions about volcanoes such as, "What is a volcano?" "What are the different types of volcanoes?" "Why do volcanoes erupt?", "Where are volcanoes found?", and "Who studies volcanoes?" This section will first explore the myths and legends surrounding volcanoes and earthquakes. Then, we will explore the physical dimensions and characteristics of a volcano. The students will be able to identify the different parts of a volcano, as well as the different types of volcanoes found around the world. The students will also become proficient with volcano terminology and vocabulary. The students will also explore and discover the reasons for volcanic eruptions, beginning with an examination of tectonic plates and earthquakes. The students will explore some of the places in the world that volcanoes can be found, with special emphasis on the Pacific Ring of Fire. The students will also examine the life and work of volcanologists, the scientists who study volcanoes.

IMPLEMENTATION

The curriculum unit should take approximately 6-7 weeks to teach. My students generally need more time to master objectives; therefore, some teachers may be able to cover the lessons at a quicker pace. The first and second sections should take about 4-5 weeks to cover, with equal amounts of time spent on each section. The last section should take about 1-2 weeks to cover. The lessons of this unit would most naturally be taught within the subject of science. However, I do not normally teach science as a subject matter. Therefore, I will teach this unit within the subjects of language arts (reading and written language). The first and second sections can easily be taught within the subject of languages arts. The last section can be taught within the subject of math, science, or art.

Section One

> *Giant smoking volcanoes stand in a row like the pipes of a cosmic organ through which the mighty breath of the earth blows its roaring music.*
>
> ~ Robert Scholten (de Boer and Sanders 1)

To answer the question "What is a volcano?" I will first discuss what a volcano is *not*. Throughout history, people have talked about volcanoes and told stories trying to explain why they behave as they do. These stories and myths were handed down from generation to generation. In some cases, these stories were the only way of preserving history. It is only in modern times that scientists have been able to accurately describe volcanoes and their behavior through scientific exploration and experimentation. I will begin my introduction of volcanoes with a discussion of the myths and legends surrounding volcanoes and earthquakes. My students love to hear folk tales and tall tales. Their fascination with superheroes, cartoons and fantasy video games attest to this fact. This will be an excellent way to grab their attention in the very beginning of the lesson. The word *volcano* comes from the Roman god Vulcan, god of fire. The early Romans thought that Vulcan worked at a hot forge making swords and armor for the other gods (Simon 1-2).

Many ancient cultures tried to explain natural events as workings of a god or gods. They gave the planet the kinds of emotions expected from humans. Therefore, when the gods were angry, they sprayed forth fire and made the ground shake. Some cultures tried to please the gods by offering prayers and sacrifices. In Nicaragua, beautiful young women were thrown into Masaya to stop the volcano from erupting. In the 1520's, the Aztecs believed that the gods were angry at the Spanish conquistadors for looting their temples. The gods' anger then caused the

volcano, Popocatelpetl, (near present day Mexico City) to erupt violently. The ancient Greeks believed that the craters of volcanoes (like the crater of Mount Vesuvius) resembled giant eyes. This may have inspired the myth of the Cyclops, a tribe of one-eyed giants that worked with Vulcan (Hephaestus to the Greeks) in his forge. The Cyclops would throw rocks and fire when they were angry, just like the craters of volcanoes (Van Rose 62).

The early Hawaiians told stories about Pele, their goddess of fire. As the legend goes, Pele's sister, Namaka, goddess of the sea, chased Pele from her home. Pele had to constantly move from one Hawaiian island to another. This made her angry and very unhappy. She eventually settled in a mountain called Kilauea, on the big island of Hawaii. The islanders tried to make Pele happy, but nevertheless, she erupted every few years. To this day, Kilauea is still an active volcano (Simon 1-2).

Ancient cultures also had myths and legends about earthquakes, as well. Earthquakes often precede the eruption of a volcano. The ancient Greeks believed that the world was held upon the shoulders of the god, Atlas. As a result of this tremendous burden, his movements caused the Earth to shake. The Mongolians thought that the Earth sat on the back of a huge frog. The frog's stumbling movements caused the ground to shake. The Hindus believe the Earth sits on the backs of eight giant elephants, whereas the Japanese believe it rests upon a giant catfish. All of these myths had the same outcome- when the animal moves, the ground shakes with an earthquake (Van Rose 63).

At this point in the lesson, I will begin implementing some instructional strategies that will help my students to better organize and understand the information presented. This is a good place to introduce a graphic organizer that will enable the students to actively participate in their learning. Instead of presenting the myths and legends only verbally, I will provide the students with a graphic organizer that the students can fill in as the information is presented. The students will be required to write the facts of the myths and legends, place of origin and a sketch or drawing to accompany the written information (i.e. a drawing of Vulcan or Cyclops).

After examining the myths and legends surrounding volcanoes and earthquakes, I will begin to answer the question, "What is a volcano?" According the Maurice Krafft, a volcano is a three-part structure. There is a reservoir (or storage chamber), a vent or pipe, and the landform that we see above ground. Miles below the ground the reservoir is filled with magma (hot melted rocks) and gas under high pressure. One or more vents allow the magma to rise to the surface where it escapes through the volcano's mouth. Once the magma exits to the Earth's surface, it is called lava (8). Every time the volcano erupts, lava flows down the outside forming a new outer layer when it cools. Ash and other materials are also thrown out during the eruption and these also add to the changing shape of the volcano's exterior. The landforms (volcano) that we can see are formed by the volcanic eruptions (Adams 7).

After discussing the parts of a volcano, the students will examine the different types of volcanoes found in the world. Although volcanoes come in many shapes and sizes, they can be grouped into four main forms: cinder cones, lava domes, shield volcanoes, and composite volcanoes. A *cinder cone volcano* is formed when an eruption hurls ash and rock that builds up, forming a steep-sided but not very tall volcano. An example of this type of volcano is Paricutin in Mexico. A *lava dome volcano* is made up of lava that is very thick and slow moving. The thick lava does not extend very far from the vent and forms cones with steep sides. Examples of this type of volcano include Mount Ngauruhoe in New Zealand and the dome presently growing within Mount St. Helens in Washington. A *shield volcano* is made of lava that is very thin and runny, and spreads a long way from the vent. As a result, the shield volcano is very large but has very gently sloping sides. Shield volcanoes are mostly made up of lava and very little ash or cinder. Some examples of this type of volcano are Mauna Loa and Kilauea in Hawaii. The

composite or strato-volcano is usually very tall. It is formed by cycles of small eruptions of runny lava and explosive eruptions of thick lava. The composite volcano also has more ash content than shield volcanoes. The combination of ash and thick lava in the eruptions make the sides very steep. Some examples of this type of volcano are Mount Shasta in California, Mount Hood in Oregon, and Mount Fuji in Japan (Bunce 14-15).

To better understand volcanoes and volcano behavior, the students need to understand the structure of the Earth and its layers. The Earth has three main compositional layers: the crust, the mantle, and the core. The core is the innermost layer of the Earth and can be found some 4000 miles below the surface. It is composed of a solid inner core of iron, nickel and sulphur, surrounded by an outer core of liquid metal under great pressure. Temperatures in the core reach a staggering 9,000 degrees Fahrenheit. Heat and pressure from the core sets the overlying mantle in motion. The mantle is the most voluminous layer of the earth. It is overlain by the crust, a thin layer typically ten to forty miles thick. The crust is the outer skin of the planet. The soft rock of the upper mantle moves slowly, forming convecting currents that drive the movement of great tectonic plates (Krafft 10). According to de Boer and Sanders, these convecting currents "are believed to be driven by heat from the Earth's core, much as convection currents are created in a pot of water heated on a stove. Hot water, being less dense than cold water, rises to the surface, where it cools, becomes denser, and therefore returns to the bottom of the pot. A similar process is believed to be at work within the Earth" (8-10).

There are several great analogies of the Earth and its layers that can be used at this point in the lesson. A hard-boiled egg or a peach can be used to demonstrate the Earth and its layers. The core is the yellow part of the egg or the pit of the peach. The mantle is the white part of the egg or the flesh of the peach. The crust is the shell of the egg or the skin of the peach. An egg is the best example because you can crack the shell to demonstrate the plates and fissures. My students would benefit from this kind of concrete example of the Earth and its layers. I would provide each student with a peach or hard-boiled egg that could be eaten after the lesson was finished.

At this point in the curriculum unit, I will begin to answer the question, "Why do volcanoes erupt?" After an examination of the Earth's layers, the students will begin to examine the reasons for volcanic eruptions. As I mentioned previously, the upper part of the mantle moves slowly, pushing and pulling the overlying plates. To explain what makes volcanoes erupt, the students need to understand the Theory of Plate Tectonics. *Tectonic* is a Greek word that means "building." The theory of plate tectonics says that the Earth's surface is fragmented into huge slabs called tectonic plates. These slabs move in response to forces and movements deep within the planet (i.e. convection within the mantle). These powerful movements allow magma to form between the plate boundaries and form volcanoes. The plate boundaries, where they collide, grind past each other or move apart, are areas of intense geological activity, for example earthquakes and volcanoes (Van Rose 10).

The tectonic plates interact with each other along their boundaries or margins. The plates interact with each other in different ways, each with different consequences. There are three different types of margins or boundaries: *convergent, divergent,* and *transform. Convergent* boundaries are places where plates are pushed together. Volcanoes formed along these types of boundaries are composite volcanoes, and are particularly volatile and dangerous. *Divergent* boundaries are places where plates are pulled apart. New ocean crust is being formed in these areas all the time. Volcanic activity (usually forming shield volcanoes) is commonplace in these areas and may build up whole islands, such as Iceland. *Transform* boundaries are places where plates slide laterally past each other. These are also called facture zones and produce powerful earthquakes but no volcanic activity (Ritchie 178-180).

An understanding of plate boundaries and plate tectonics help to answer the question "Where are volcanoes found?" Volcanoes do not appear randomly around the world. Volcanoes and earthquakes both occur most often along the edges of plate boundaries or margins as I stated previously. Magma usually rises to the surface at the edges of plates. This means that volcanoes are spaced out around the Earth in long, thin lines. One string of volcanoes stretches down the middle of the Atlantic Ocean. This chain of volcanoes is called the Mid-Atlantic Ridge and marks the place where plates are pulling apart to form new ocean crust (divergent). Another plate edge stretches all the way around the Pacific Ocean. This is a place where the tectonic plates collide (convergent). It contains many violent, explosive volcanoes. This chain of volcanoes is called the Pacific Ring of Fire (Knapp 7).

There is, however, one exception to the plate-tectonic control on where volcanoes form. There are localized areas beneath the crust where mantle plumes rise to form "hot spots." These hot spots generate the magma to form volcanoes such as those found in Hawaii and Yellowstone.

At this point in the curriculum unit, I will address the question of "Who studies volcanoes?" I think it is important for my students to learn through discovery the many and varied careers available to them. If my students are excited about volcanoes as a result of this curriculum unit, then just maybe they will become excited about working with them when they grow up. I will begin by explaining that a volcanologist is a scientist who studies volcanoes by watching, recording, and interpreting volcanic activity. They study volcanoes so that they can tell when and how the volcano might erupt, and they record details of the eruptions. They work in scientific laboratories, but they sometimes have to visit the actual volcano, while it is erupting (Adams 28). The work in the field for the volcanologist often involves taking lava and gas samples and measuring changes in temperature and landforms. The accuracy of eruption predictions rose in the early 2000's when scientists identified vibrations, or tremors, lasting a minute or more. As their frequency increases, scientists hope to be able to predict the time of an eruption (Van Rose 42).

After the eruption of Mount St. Helens in 1980, the United States government set up full-time volcano labs in California, Alaska, and Washington. A special quick-response force known as the U.S. Volcano Disaster Assistance Program was created. Within 48 hours of the first signs of trouble from an awakening volcano, volcanologists are on the scene. The volcanologists use a combination of ground instruments and space satellites to measure the movement of materials in the volcano. By doing this, the scientists hope to predict when a volcano will erupt. Volcanologists used to measure pre-eruption gases by climbing directly into the volcano. In 1993, five volcanologists were killed as a result of the sudden eruption of Galeras in Colombia. One of the surviving volcanologists, Stanley Williams, began work on a remote gas sensor that can read a volcano's emissions from a plane flying nearby ("Kaboom! Volcanoes Pose a Threat").

The life of a volcanologist is fraught with danger and excitement. Many scientists look to the life of two famous volcanologists for inspiration. French scientists and husband and wife team, Maurice and Katia Krafft, worked together to study, photograph and film volcanoes all over the world. They were killed along with 39 other people during the 1991 eruption of Mount Unzen in Japan (Sutherland 15).

Section Two

> *The great rocks of the mountains will throw out fire; so that they will burn the timber and many vast forests, and many beasts, both wild and tame.*
>
> ~ Leonardo Da Vinci (Levy and Salvadori 45)

The second section of the curriculum unit will explore several famous volcanoes from around the world and significant volcanic eruptions connected to those volcanoes. Some of the volcanoes the students will explore in this section include Mount Vesuvius in Italy A.D. 79, Krakatoa in Indonesia 1883, Mount Pélée in Martinique 1902, Mount St. Helens in the United States 1980, and Nevada Del Ruiz in Columbia 1985. Within this section, the student will examine each of these volcanoes and their eruptions from the human perspective. The students will explore the statistics of each of these volcanic events, such as when and where did it happen, what were the human and economic losses associated with each, and what were the environmental effects. The students will answer the question "What was the human response to the volcanic event?" The students will explore the ways in which the people from that place and time responded to the devastation of the volcanic eruption. The students will compare and contrast these responses to determine what lessons have been learned about volcanic hazards. The students will finish this section by examining some of the benefits of volcanoes.

Mount Vesuvius

The first volcano we will examine is Mount Vesuvius in Naples, Italy. This volcano is not located in the Pacific Ring of Fire. However, it is a composite volcano that is located on a convergent plate boundary (place where tectonic plates are colliding together). Mount Vesuvius erupted violently on August 24, A.D. 79. The volcano had been quiet for many years. The residents of the Roman towns of Pompeii and Herculaneum were taken by surprise (Van Rose 26). It is unclear how many people were killed in the aftermath of the eruption. However, the town of Pompeii was covered in 23 feet of hot ash and cinders. People in the nearby town of Herculaneum were also killed by the blast of hot ash and gas. The ash set like cement around the people killed in Pompeii. Their bodies decayed, leaving hollow shells. Years later, scientists made plaster casts of the bodies (Adams 22). The two towns of Pompeii and Herculaneum went virtually forgotten until excavations began in the 18th century. The eruption of Mount Vesuvius was the first in human history described in detail. The eruption was witnessed by Pliny the Younger who described the events in two letters to Tacitus. Pliny the Younger was a scholar who watched the eruption cloud from eighteen miles away across the Bay of Naples, where he was staying with his uncle, Pliny the Elder (Van Rose 26).

Krakatoa

The second volcano we will examine is Krakatoa, a tiny uninhabited volcanic island in the South Pacific. It is a composite volcano located in the Pacific Ring of Fire (convergent plate boundary). Today, Krakatoa and the surrounding islands are part of the Republic of Indonesia. However, in the year 1883, they were controlled by the Netherlands. There were many small villages and towns on the surrounding islands. It was a thriving ship passageway and seaport. Although Krakatoa was known as a volcanic island, there were no accounts of volcanic activity since the 17th century. Then, on August 27, 1883, after weeks of activity, a series of four blasts tore apart the island. The blasts were so loud that they could be heard 3,000 miles away in the Indian Ocean. As a result of the explosion, two-thirds of the island collapsed beneath the sea (de Boer and Sanders 167-168).

In the aftermath of Krakatoa's eruption, 165 villages were destroyed and nearly 37,000 people died. How is this possible for an island that was uninhabited at the time? The destruction caused by the eruption of Krakatoa was phenomenal as well as unique. The collapse of the island generated immense sea-waves (tsunamis) that crashed into the surrounding island towns and villages. It was not fire, ash, gas, nor burning lava from the volcano that killed the victims of Krakatoa. All but approximately 1000 of the victims were drowned or swept out to sea (Winchester 240-243).

Mount Pélée

The third volcano we will examine is Mount Pélée on the island of Martinique in the Caribbean. Mount Pélée is a composite volcano located on a convergent plate boundary. On May 8, 1902, Mount Pélée erupted violently, sending a super-hot cloud of ash, rock and gas (better known as a pyroclastic flow) directly into the city of Saint Pierre. Within minutes, the poisonous cloud killed 34,000 people. This was the first recognized and documented example of a pyroclastic flow. Unfortunately, Mount Pélée had provided many warnings of the upcoming eruption that science was unable to understand at the time. Emissions of clouds of smoke, ash, lava and mud began as early as April 1902. On May 5, 1902, twenty people were killed as a result of these emissions. After these warning signs, government officials discouraged and even prohibited the evacuation of people from the city of Saint Pierre, with devastating consequences. One of the only survivors of the eruption was a prisoner that was locked in a dungeon-like cell in a local prison. His sentence was eventually suspended, and he spent the rest of his life touring the United States with the Barnum and Bailey Circus (de Boer and Sanders186-187, 204).

Mount St. Helens

The fourth volcano we will examine is Mount St. Helens in the United States. Mount St. Helens is a composite volcano located in the Pacific Ring of Fire (convergent plate boundary). Mount St. Helens had been dormant for 123 years. Then, on May 18, 1980, she erupted violently, blowing the top of the mountain off. The eruption caused $1.5 billion in damages, destroying $100 million in crops and demolishing 150 square miles of timber. Fifty-seven people died as a result of the eruption. The eruption of Mount St. Helens was the most photographed and thoroughly documented volcanic event in human history. Compared to the eruption of Mount Pélée in 1902, the eruption of Mount St. Helens caused relatively little loss of life. This can be attributed to the advancements in the science of volcanology and the government's response to the warning signs. In March of 1980, a series of earthquakes was followed by eruptions of steam and ash. The northern side of the mountain began to bulge outward ominously. As a result, the governor of Washington declared a state of emergency and the National Guard took steps to prevent onlookers from approaching the volcano (Ritchie 196).

In 1982, Congress set aside 110,000 acres around the volcano and named it Mount St. Helens National Volcanic Monument. Inside the monument the land was left unchanged since the eruption. Scientists have been studying the area ever since to learn about the effects of the eruption and the return to life in the area (Lauber 24).

Nevado del Ruiz

The last volcano we will examine is Nevado del Ruiz in Columbia. Nevado del Ruiz is a composite volcano also located in the Pacific Ring of Fire (convergent plate boundary). Nevado del Ruiz is the tallest of the Columbian volcanoes. The summit of the volcano is covered with snow and ice. *Nevado* means "snow-capped" in Spanish. The volcano was known to produce small volume eruptions. The danger came when the eruptions melted the snow and ice on top, causing deadly mudflows (also known as lahars) down to the valley below. This happened in 1845, killing 1,000 people. The little village of Armero was built directly atop the 1845 mudflow deposit. On November 13, 1985, history repeated itself. Nevado del Ruiz erupted, melted the snow and ice at the summit, and sent a deadly mudflow rushing down the mountain. The small village of Armero was totally destroyed and 23,000 people were killed. Unfortunately, this tragedy could have been avoided. Nevado del Ruiz had been producing steam eruptions and earthquakes for 51 weeks prior to the November 13th eruption. Geologists had warned of a 100% probability of mudflows with great danger to Armero. However, government officials dismissed the reports as too alarming. On the day of the violent eruption, the Red Cross had ordered an evacuation, but government officials called it off (Camp).

Famous Volcanic Events in History

Following is an easy reference table for the volcanoes the students will be examining in this part of the curriculum unit:

Volcano & Type	Date of Eruption	Location	Consequences
Mount Vesuvius- Composite Volcano	August 24, A.D. 79	Italy- Convergent Plate Boundary	The cities of Pompeii and Herculaneum were destroyed. Thousands of people killed by heat, ash and gas emissions.
Krakatoa- Composite Volcano	August 27, 1883	Uninhabited island in the South Pacific (Pacific Ring of Fire)- Convergent Plate Boundary	37,000 people on surrounding islands were drown or swept out to sea by tsunami waves produced by the collapse of the island.
Mount Pélée - Composite Volcano	May 8, 1902	Island of Martinique in the Caribbean- Convergent Plate Boundary	The city of Saint Pierre was destroyed and 34,000 people killed by pyroclastic flows (hot ash, rock and gas).
Mount St. Helens- Composite Volcano	May 18, 1980	Washington, United States (Pacific Ring of Fire)- Convergent Plate Boundary	The top of the mountain was blown off, 57 people died, 150 sq. miles of timber destroyed and $1.5 billion in damages.
Nevado del Ruiz- Composite Volcano	November 13, 1985	Columbia (Pacific Ring of Fire)- Convergent Plate Boundary	The village of Armero is destroyed and 23,000 people killed from mudflows (lahars).

After an examination of these famous volcanic events in history, the students will discuss the lessons learned from these events. There are several points that I want my students to discuss after studying these volcanoes and their devastating eruptions. The first lesson I want my students to discuss is that of listening to the experts. Over the centuries, the science of volcanology and geology has grown and improved immensely. When Mount Vesuvius erupted in A.D 79, many people died as a result of ignorance. Scientists simply did not know the dangers of living in the shadow of an active volcano. However, today scientists know the warning signs of an impending eruption. Government officials as well as people living in the danger zones must be willing to evacuate the area when the scientists give their warnings. The most obvious example of this is the loss of life in Saint Pierre and Armero. Both of these disasters were preceded by volcanic activity that scientists confirmed to be dangerous. These warnings were ignored or down played and the results were devastating.

A third lesson I want my students to discuss is the dangers of building towns and cities in the shadow of active volcanoes. There are many cities throughout the world that grow and thrive in

very high risk areas. Eastern Asia and Central and South America have millions of people living in danger zones. Unfortunately, the main problem facing the governments of these areas is how to effectively warn the people and how to organize a speedy escape when danger threatens. In underdeveloped countries, many people live in remote areas and many do not have televisions or radios. Effective warning systems and safe transport out of the areas can be very difficult. The eruption of Mount St. Helens is a good example of government officials heeding the warnings of scientists. Many people were evacuated from the areas surrounding the volcano when she began to demonstrate activity. As a result, only fifty-seven people were lost (Knapp 34-35).

Another lesson I want my students to discuss is the planning and preventing of disasters in the high risk areas. Engineers in these areas have discovered that the paths of slow flows of lava and some mudflows can be changed with the use of dams and channels. The Japanese have set up special detectors that warn of mudflows and cameras trained on the danger spots. The idea is to give towns and villages time to evacuate before the mudflows arrive. Japan has become the world's leader in mudflow prevention (Knapp 35).

After the discussion of these devastating volcanic events, I do not want my students to fear or hate volcanoes. I want my students to have a healthy respect and fascination for these amazing forces of nature. I will finish this section of the curriculum unit with a discussion of the benefits of volcanoes. One of the benefits of volcanoes is that it produces very fertile soil for growing plants. In Indonesia, the ash that is released from the frequent eruptions makes for some of the most fertile soil in the world. This natural fertilizer is free and falls from the sky. The fertile soil provides food for many people (Krafft 54).

Other benefits of volcanoes are tourism and minerals for industry. Many volcanoes are sites of great beauty and splendor. These places attract thousands of visitors each year. Many people visit the volcanoes to see the snow capped mountains, beautiful lakes and unusual plants that grow on the mountainside. The cities and towns surrounding the volcanoes benefit greatly from the tourist dollars generated each year. Many countries also benefit from the discovery of gold, silver, tin, copper, iron and other minerals that are formed from volcanic activity. The Gold and Silver Rushes in the United States in the 19th century can be attributed to mining in the roots of old volcanoes (Knapp 42-45).

Section Three

What time does the volcano erupt?
~ Tourist on Mt. Etna in 2000 (www.volcanolive.com)

The third section of the curriculum unit will involve hands-on experiences with volcanoes. Many of my students are visual and multi-sensory learners. Therefore, the last section of the curriculum unit will include hands-on activities that will help the students better understand the parts of a volcano and the ways that they work.

The following experiments and demonstrations can be implemented in a variety of ways. My students learn best when the experiment or demonstration is done immediately following the presentation of the objectives or class discussion. However, the experiments and demonstrations can also be done at a later time. The following experiments and demonstrations were obtained from Janice Van Cleave's book, *Volcanoes: Mind Boggling Experiments You Can Turn Into Science Fair Projects* listed in the bibliography. Refer to text for specific details on implementation and materials needed for experiments and demonstrations. After the discussion of the different types of volcanoes, I will demonstrate the way that a composite volcano is formed (36-39). After the discussion of plate tectonics, I will demonstrate why volcanoes occur in the places where the plates are colliding, moving apart and sliding past each other (32-35). After the discussion of volcanic eruptions, I will demonstrate a volcanic eruption (20-22). After the

discussion of volcanologists, I will demonstrate a tiltmeter that is used by scientists to determine when a volcano will erupt (48-51).

LESSON PLANS

Lesson One

This lesson will be taught to 3rd-5th grade students with disabilities. It will take place after the students have learned how to answer the question "What is a volcano?" The objective of this lesson is to compare and contrast the information presented about the myths surrounding volcanoes from the past and the facts we have learned through scientific discovery. The students will create a poster presentation that is a comparison of the myths and facts about volcanoes. The goal of this lesson is for the students to demonstrate a clear understanding of how our knowledge of volcanoes has changed through the centuries. I want my students to have a strong confidence about science. I want them to understand that humanity throughout history is constantly moving away from helpless and fearful superstitions to confident knowledge through scientific exploration and discovery.

This lesson will begin with a review of the myths surrounding volcanoes and earthquakes. In a previous lesson, the students used a graphic organizer to organize the information about volcano myths. The students will now use this information to complete the poster presentation. The students will also need a tri-fold poster, ruler, and pens or markers.

Each student will work with a partner to complete this project. The students will begin by labeling the left-hand section of the poster "We believed…" and labeling the right-hand section of the poster "Now we know…" The students will list the information from the graphic organizer on the left-hand side of the poster (We believed…). This part of the lesson is done independently by the students with guidance and supervision from me.

The students will then begin to complete the right-hand section of the poster (Now we know…). This part of the lesson is done after a class discussion to review facts about volcanoes (i.e. three part structure of a volcano, types of volcanoes, layers of the Earth, tectonic plates and Pacific Ring of Fire.) As the class reviews volcano facts, I will write the facts on the whiteboard. The students will then use those facts to complete the right-hand section of the poster.

Many of my students enjoy drawing or sketching. I try as much as possible to include an art portion to my lessons. This is the art portion of the lesson. After both sections of the poster are complete, the student will begin the middle section of the poster. The middle section of the poster is reserved for the student's sketches or drawings. The sketches or drawings must illustrate the facts that are included on the right and left sections of the poster.

Lesson Two

This lesson will be taught to 3rd-5th grade students with disabilities. This lesson will take place after the students have learned about the different types of volcanoes and plate tectonics. The objective of this lesson is to compare and contrast two different types of volcanoes: shield volcanoes and composite volcanoes. The students will use a graphic organizer to explore the similarities and differences between shield volcanoes and composite volcanoes. The goal of this lesson is for the students to have a clear understanding of the hazards associated with two different types of volcanoes and how the hazards are related to their locations on our planet. The students will also answer the question "Which type of volcano is the most dangerous and why?"

This lesson will begin with a review of the different types of volcanoes. This lesson will focus on the characteristics and hazards of shield volcanoes and composite volcanoes. The students will review previously presented information about these two volcanoes. The students

will also review the theory of plate tectonics and plate boundaries, focusing on convergent and divergent plate boundaries.

After a review of shield and composite volcanoes, the theory of plate tectonics and plate boundaries, the students will watch two videos. The first video is titled *Inside Hawaiian Volcanoes*. This video explores Hawaiian shield volcanoes and the associated hazards. The second video is titled *The Eruption of Mount St. Helens*. This video explores the 1980 eruption of Mount St. Helens (a composite volcano) and the effects that follow.

After the teacher-guided portion of the lesson, the students will work independently with teacher guidance and supervision to compare and contrast the similarities and differences between shield and composite volcanoes. The students will need a Venn diagram and pencils. A Venn diagram is a graphic organizer composed of two, large over-lapping circles. The outer portion of the two circles is used to list differences and the one center portion is used to list similarities. The students can make the Venn diagrams themselves or they can be computer generated by the teacher. The students will title one side of the diagram *Shield Volcanoes* and the other side *Composite Volcanoes*. The students will list all characteristics specific to each volcano under the appropriate heading. The students will then list all characteristics common to both volcanoes in the center portion.

The last portion of the lesson will come after the completion of the Venn diagrams. The students will answer the question "Which type of volcano is the most dangerous and why?" (Hint: Composite volcanoes located on convergent plate boundaries.)

Lesson Three

This lesson will be taught to 3rd-5th grade students with disabilities. This lesson will start at the beginning of the curriculum unit and end at the completion of the unit. The objective of this lesson is to record the daily activity of a specific volcano using information from the Internet and life webcams. The students will keep a daily journal of the activity of a volcano during the course of this curriculum unit. The goal of this lesson is to give the students the opportunity to experience what it is like to be a volcanologist. I want my students to understand that being a volcanologist involves patience, commitment and perseverance. I want my students to know that being a volcanologist can be very exciting and dangerous when the volcano is active. However, the day to day monitoring of a volcano can be repetitious and uneventful.

The lesson will begin with an introduction to the various volcano observatories around the world that can be accessed through the Internet. I will use the link found on the USGS Home Page (www.usgs.gov). The full URL is listed in the works cited section of the bibliography. The students will be given the opportunity to choose the volcano they wish to observe and follow. I will show the students the information that can be found on the various websites, and what information they will need to include in their daily journal entries.

After the students have chosen a volcano to track, they will log on to the Internet each day and proceed to the website designated for their volcano. They will read the current statistics and information about their volcano and observe the activity from the live web cam. The students will have to include the following information in their daily journal entries: name of volcano, location of volcano, name of observatory, date, time of day, weather report, alert level, recent observations and description of view from web cam with accompanying sketch. The students will share any significant volcanic activity that day with the class.

At the completion of the curriculum unit, the student will review their volcano journal and write a summary of their findings. The student will then give a brief presentation to the class of their volcano and any significant activity during the 6-week period.

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Volcanoes - Geological and Geophysical Setting, Theoretical Aspects and Numerical Modeling, Applications to Industry and Their Impact on the Human Health. Edited by Gemma Aiello. Show +.Â [40] started a follow-up study and evaluated the impact on the respiratory health of the residents. The authors found that the mean SO2 concentration in the air ranged from 6.64 to 12.6 ppb with a maximum concentration between 1580 and 1880 ppb from November 2006 to 2011. The authors observed clear dose-response relationships with symptoms of irritation and established a threshold concentration of approximately 70 ppb in adults. Volcanic ash can impact the infrastructure of entire communities and regions. Ash can enter and disrupt the functioning of machinery found in power supply, water supply, sewage treatment, and communication facilities. Heavy ash fall can also inhibit road and rail traffic and damage vehicles.Â Carbon dioxide and fluorine, gases that can be toxic to humans, can collect in volcanic ash. The resulting ash fall can lead to crop failure, animal death and deformity, and human illness. Ashâ€™s abrasive particles can scratch the surface of the skin and eyes, causing discomfort and inflammation.Â Their guidelines are used throughout the world by city and town governments and by the citizens they serve. Volcanic ash can ascend hundreds of kilometers into the atmosphereâ€”and stay there for years. Volcanoes are explosive things of beauty that can tell us much about our past, and that have an impact on our futures. Like humans, sometimes they are passive and unnoticeable, appreciated for their history and geological importance, sometimes aggressive. Why are volcanoes extreme for humans? The heat is too extreme for humans to survive. How do humans impact the desert? Humans impact the desert by the things they do to the desert or in the desert. What do you think will happen to the amount of volcanoes and what impact will it have on farming? The amount of volcanoes will tend to increase, wh