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TEACHING WEATHERING AND EROSION WITH AN EMPHASIS OF HANDS-ON ACTIVITIES TO MIDDLE SCHOOL STUDENTS

By

Nicole McGaugh

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ABSTRACT

TEACHING WEATHERING AND EROSION WITH AN EMPHASIS OF HANDS-ON ACTIVITIES TO MIDDLE SCHOOL STUDENTS

By

Nicole McGaugh

During the 2005-2006 school years, seventh grade students at Holt Junior High School completed a unit on weathering and erosion. This unit was developed to include more hands-on activities for students. According to the Piaget theory, middle school students are in transition cognitively. Middle school students have concrete operational thought skills but many do not have formal operation thought skills. Based on this fact, middle school students learn the best when concrete activities are provided for them. From these concrete activities, students can have more success in mastering new concepts. Various new activities were developed to help students master concepts involving weathering and erosion. Data were collected by using a pretest and posttest to measure the effectiveness of the various activities.

These data showed students had gained in their knowledge of weathering and erosion. Students were also successful in showing their knowledge by writing poetry at the end of the unit.

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Introduction

Physical science and earth science are both taught in seventh grade science class at Holt Public Schools. Several activities had been developed for the physical science portion of the course. The earth science portion of the course covers the atmosphere, weather, rocks and the rock cycle, weathering, erosion, soil formation, earth's features and the water cycle. The units covering the atmosphere, weather and rocks have several activities for students. Activities had not been developed for weathering, erosion, and deposition. A stream table had been purchased to help students learn about deposition and river formation but activities had not been developed to make use of the stream table. As a former geologist, I was committed to developing activities related to use of a stream table. This unit was developed to provide students with activities to cover weathering, erosion, soil formation, deposition and the water cycle. Another important aspect of the unit was to help students apply what they learned in the classroom to real life situations. It was hypothesized that students would be successful in learning the required material for these topics as measured by pre-test and post-test comparisons.

The starting point of the project was to identify the objectives to be taught. Holt Public Schools have devoted large amounts of time and effort to determine what objectives are to be covered at each grade level. There was a lack of hands-on activities in the earth science portion of the curriculum. This led to looking at the following objectives. These objectives are from the Michigan Content Standards and

Benchmarks identified by the school district. The four benchmarks chosen are as follows:

1. All students will describe and explain how the earth's features change over time.
2. All students will describe how water moves.
3. All students will analyze effects of technology on the earth's surface and resources.
4. All students will analyze the relationships between human activities and the atmosphere.

The first objective includes having students explain how rocks are broken down, how soil is formed and how surface features change which includes chemical and mechanical weathering and erosion by water, wind, ice and gravity. For the second objective, students should be able to describe how surface water in Michigan reaches the ocean and returns. This includes key concepts such as water path – runoff, creeks, rivers, streams, wetlands and the Great Lakes. The third objective includes students being able to explain concepts such as farming, urban development, surface mining and construction and how these affect the earth. The fourth objective has students being able to describe the health effects of polluted air that includes key concepts such as sources – car exhaust, industrial emissions and acid rain. These objectives were then used to develop hands-on activities.

A major goal for science is for students to become scientifically literate. The goals for school science that underlie the National Science Education Standards (National Research Council, 1996) are to educate students who are able to:

- Experience the richness and excitement of knowing about and understanding the natural world;
- Use appropriate scientific processes and principles in making personal decisions;
- Engage intelligently in public discourse and debate about matters of scientific and technological concern; and
- Increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers.

These goals define a scientifically literate society. Being scientifically literate means that one can ask, find or determine answers to questions from everyday life about the environment in which he or she lives (Sunal, 2003). A scientifically literate person does not necessarily need to know all of the facts or content of a science topic but can be given information and draw conclusions from it.

The middle school or junior high school science experience is very important for students. At this time, students can start to become scientifically literate. At the elementary level, science is not always adequately taught (Meichtry, 1992). In high school, many students do not enroll in science class unless they are in a college preparatory track. The nature of science instruction delivered during the middle school years thus plays a vital role in a science education designed to facilitate the scientific literacy of all students. Many students during the middle grades have a change in attitude about science. Students start school with enthusiasm and curiosity. As students progress through school, this attitude can change to boredom. This change may occur for two reasons. The first is that science is taught as facts which may students may not have any interest in or connections to their lives. The second is teachers often have attitudes that there is only one source of information, one right answer and one textbook in which answers are found (Wolfinger, 2000) To prevent students from perceiving science as dull and routine, teachers need to use several sources and hands-on activities to keep students interested and excited about science. Based on this information, science instruction during the middle grades is vital for students to become scientifically literate.

Middle school students are in a transitional period, physically, socially and cognitively. Physically, students are different sizes and shapes with some having reached puberty while others have not. Typically, during the middle grades several elementary schools are coming together to form a bigger middle school. Because of this, students are in transition socially. Piaget's theory of cognitive development has middle school students in a transition period between two different stages of thinking processes. The stage almost all middle students have reached is cognitively is generally termed as the concrete operational stage. This stage occurs when a child is approximately 7 years old and lasts until they reach the next stage. During this stage,

> The child understands and applies logical operations or principles to help interpret experiences objectively and rationally rather than intuitively. By

> applying logical abilities, children learn to understand the basic ideas of conservation, number, classification and many other scientific ideas. (as explained in Berger, 1994)

Middle school students are starting to transition or move to the next stage, generally termed as the formal operational stage. This stage starts when a child is approximately 12 years old. During this stage,

> the adolescent or young adult is able to think about abstraction and hypothetical concepts and is able to speculate in thought "from the real to the possible." Ethics, politics and social and moral issues become more interesting and involving as the adolescent becomes able to take broader and more theoretical approach to experience. (as explained in Berger, 1994)

Students at the middle school levels may just be starting to think abstractly and with some formal operational thought processes. Many students, however, have not started this transition into formal operation thought and may not do so until high school or beyond. Since cognitive functioning is an important part of understanding the learning process in students, Piaget's theory must be considered when designing and implementing new curricula as well as helping students become scientifically literate.

With Piaget's theory and scientific literacy in mind, middle school students need to be active learners. Merely reading a textbook or having a teacher lecture to them is not going to allow these students to master material or use it in their lives. This results in students who can memorize a variety of terms but often cannot apply them to problems or outside experiences because they do not truly understand them (Schulte, 1996). Middle school students need a variety of activities and experiences to help them learn material. These concrete experiences will then help students be able to take the knowledge they have mastered and apply it to new situations. This is the first step in formal operational thought as well as becoming a scientifically literate individual. A few middle school students are able to take abstract information and use if effectively. However, most need concrete examples to do this.

Middle school students also need hands-on activities to become scientifically literate. There have been studies done that compare a "traditional" classroom with lectures and readings to one that is an activity-based. Wollman and Lawson studied seventh grade students comparing two different groups of students learning proportions (1978). Proportions are an important concept in both mathematics and science. Many concepts in science use proportions such as density, velocity and acceleration. Density is the proportion of mass to volume. Many students have problems with understanding proportions; therefore, they have difficulty when they need to apply proportions to real life problems. If a student does not fully understand a concept then they are unable to apply it to their life which is part of becoming scientifically literate. In Wollman's study, the first group of students was taught proportions in a traditional method with a textbook and algorithm. The second group was taught proportions using concrete examples and manipulative materials. A post-test was given to both groups of students that asked students to apply proportions to real life problems. The active group that used concrete examples and manipulative materials had better scores on the post-test than the students that just learned the algorithm. The "activities" group may well have profited from being truly challenged. They often attempted problems which proved too difficult, whereas the "traditional" group did intellectually unchallenging "piecework" as they learned the steps of the usual algorithmic procedure. The Wollman study shows the importance for middle school students to have concrete examples and activities in learning and mastering new material.

A second study also compared methods of instruction for two different groups of ninth grade students (Schneider, 1980). In this study, one group of students was taught using formal instruction with textbooks and the second group of students was taught using concrete activities using manipulative materials. Students were taught units in physical science such as static electricity, current electricity, light and optics and sound. A post-test which consisted of multiple choice and free response questions was given to both groups after the unit was taught and a second time, three months after the unit was taught. The group that was taught with concrete activities had better scores on the post-test given after the unit was taught as well as the post-test given three months later. This indicates that concrete activities should be used whenever possible since the content taught is retained over a longer period of time. Students need to retain and understand concepts so they can apply them to problem solving as it pertains to their lives.

A study by Chang (1999) compared instructional methods and achievement levels for ninth grade earth science classrooms. The first group of students received cooperative learning instruction where students worked in groups for hands-on activities as well as small group discussions and inquiry. The second group of students received the same instruction, hands-on activities and assignments but did not work together. This study showed that gains in both knowledge and comprehension were the same for both groups on the post-test. However, the cooperative learning group had significantly higher scores on the application portion of the post-test. This study suggests that having students work together and discuss new concepts helps promote higher level thinking skills. These higher level thinking skills are important for students to be able apply what they have learned and apply it their own lives.

Having students participate in hands-on, concrete activities is not enough to ensure they will learn content as well as become scientifically literate. For example, the activities need to be relevant and meaningful. They also need to help middle school students make the transition from concrete operational thought to formal operational thought processes. Science process skills must also be incorporated into these activities so that they can be transferred into life skills. This is one of the objectives for becoming a scientifically literate individual. The idea of how to conduct an experiment is one of the major process skills students should acquire at the middle school level (Padilla, 1980). Students should be able to ask questions, identify variables, hypothesize, collect and graph data, and make conclusions from their observations and data. Students should be able to understand the concept of variables so they can identify manipulated, responding and control variables. Students will develop this skill when they individually encounter problems, propose possible explanations, design and carry out tests, and draw conclusions (Cousuegra, 1980). Therefore activities must be developed that include process skills as well as manipulating variables. Furthermore, teachers need to spend an adequate amount of time explaining, discussing and integrating activity results (Padilla, 1980) By doing this, teachers are helping students to draw conclusions about the material they have been learning and apply it to themselves which is important for becoming scientifically literate.

Another important aspect when designing activities is student interest. Many students during the middle school years lose interest in science. A study by Martinez (1991) was done to determine what makes activities and experiments interesting to middle school students. Characteristics of interesting experiments were divided into three clusters: cognitive appeal, mastery appeal and social appeal. The cognitive appeal cluster dealt with students learning more, discovering new things, doing something different, not knowing how the experiment will turn out, feeling challenged and seeing changes in what they are doing. The mastery appeal cluster dealt with getting to make things, taking things apart, putting things together, and getting to use equipment. The social appeal cluster included getting to work with a friend and getting to talk about ideas. Each of these clusters should try to be included when designing activities for middle school students. If the students are interested in what they are learning then they will have a greater chance of success in learning the material and applying it to their lives.

Many middle school students do not feel that they are successful or very good at "doing" science. One way to change this attitude is for students to participate in hands-on activities. Carter (2001) studied how hands-on activities affected learning as well as attitudes about science. In this study, a hands-on lesson was conducted either about light or matter. Before the lesson, students were given a pre-test which included both questions about the content being taught as well as questions about student's attitudes about science. After the lesson, the same post-test was given. The post-test showed students had increased their knowledge about the given content. A second finding was that more students felt that they could "do" and understand science after completing the hands-on activities. The last finding was the most interesting in that after participating in hands-on activities, many students changed career choices to include science or science related fields. Although achievement and career potential do not guarantee scientific literacy, their power cannot be ignored (Carter, 2001).

A second study involving student achievement, student attitude and hands-on or laboratory activities had similar findings (Freedman, 1997). In this study, students were either in a laboratory class or non-laboratory class. Students were given a mid term and final exam which consisted of multiple choice questions. Students were also given a survey at the end of the year to determine attitudes about science. It was found that scores were better on the post-test for the laboratory classes than non-laboratory classes. The attitude of students towards science was more positive for the laboratory class students. It was concluded that laboratory instruction influenced, in a positive direction, the students' attitude towards science and influenced their achievement in science knowledge.

An important part of scientific literacy is students being able to read and write about science. Many times textbooks are at a high reading level and many students have a difficult time learning material from them. Science trade books which can include biographies, science fiction, realistic fiction, picture books and informational books, help students learn new material as well as produce positive attitudes about science. Fisher (1980) determined how literature used with the textbook would influence seventh graders learning about life science. In this study, there were three groups. The first group was a control group that just used the textbook for reading. A second group used the textbook but had books in the classroom for their use. The third group was required to read both the textbook and specific books from the classroom/library collection. Both of the groups that used literature had higher scores on a test given after the unit was taught as compared to the group that did not use literature. The use of trade books stimulated talk outside class about science, and made them feel more like science was part of life and not just academia.

Being able to communicate ideas about science is also an important of becoming a scientifically literate individual. Writing is one of the most valuable tools a student can possess. Regardless of what type of profession a student chooses, writing will most likely be part of his/her job. Preparing students to be scientifically literate citizens and ready for future coursework demands teachers take time and effort to teach writing strategies embedded in middle school science (Holliday, 2000) Writing can include but is not limited to writing observations, conclusions and papers. Writing is also an effective tool in science for expanding and internalizing learning (Freeman, 2006). Writing is also a significant component of the work of a scientist. Scientists have to be able to report their findings, publish journal articles and communicate with other scientists. Students need to be able to write to become scientifically literate individuals. One type of writing not typically taught in the science classroom is poetry. This type of writing evaluates knowledge while allowing students to give creative thought to their learning (Robertson, 1997). This type of writing also shows students a direct correlation between disciplines. Poetry also allows students to make connections between the science material and their own lives. As students put their own words to the scientific concepts they are learning, science finds deeper meaning and poetry becomes its voice (LaBonty, 2005). By including different types of writing in science class, a teacher helps students become scientifically literate.

In summary, when designing a unit for a middle school science class there are many factors a teacher must consider. One factor is the cognitive development of the students. According to Piaget's theory, students need concrete examples and activities to master new materials. This is best shown by having hands-on activities for the students. Another important factor is scientific literacy. To create scientifically literate students, teachers must help students connect the material they learn to their own lives. This can also be done with hands-on activities as well as providing students with literature and writing assignments. Hands-on activities and literature have also been shown to create students with positive attitudes towards science and science related topics. This positive attitude can then be transferred to student's lives as they continue with their science education.

Science Background

Weathering is the process by which rocks are broken down into sediments. There are two types of weathering, mechanical and chemical. Mechanical weathering is when physical processes such as ice, abrasion, wind, water, gravity, plants and animals break down rocks. Mechanical weathering does not change the molecular structure of the rock, the rock just becomes smaller. Ice expands in cracks and breaks down rocks. Abrasion is when rocks collide and rub against each other. This can be caused by wind, water and gravity. Wind can blow sand and sediments against rocks causing them to become smaller. Waves or water flowing in a river can cause rocks to weather. Rock slides caused by gravity can also weather rocks. A plant's root actions can also mechanically break down rocks. Animals that burrow and let water into the soil and rocks cause weathering. Chemical weathering is when chemical processes such as water, acids and air break down rocks. Chemical weathering changes the molecular structure of the rock as well as breaks down the rock. Water can dissolve rocks and create chemical weathering. Acid precipitation also causes rocks to become weathered. Weak acids can also dissolve limestone to eventually create caves and weathering. Rust is chemical weathering produced by air and oxidation of iron. Water can cause both mechanical weathering and chemical weathering.

Erosion is the process by which rocks and sediments are moved and deposited. Erosion can occur due to water, wind, ice and gravity. Water moves sediments using waves, rivers and streams, as well as runoff. Wind blows sediments from one location to another and then deposits them. Glaciers and ice can move large amounts of sediments and rocks. This occurs as material gets frozen in the ice and the ice moves due to its weight and gravity. As the ice melts, material is deposited. Glaciers can have rivers underneath them which carry sediments.

Rivers can carry large amounts of sediments and deposit them. An example of how powerful a river is can be seen at the Grand Canyon. The Grand Canyon was formed over millions of years by the erosion of Colorado River. Erosion occurs at the banks of a river and sediments are deposited at the mouth of the river. Three factors, gradient, discharge and load, influence a river's ability to erode. The gradient of a river is the change in elevation over a given area. A river that has a steep gradient can carry more sediment than a river with a shallow gradient since more sediments can flow down hill. The discharge of a river is the amount of water the stream carries over a given amount of time. If a river carries a large volume of water, it will be capable of eroding more sediment than a river that carries a smaller volume of water. The amount of sediments a river carries is the load. Rivers also have different stages. A youthful river has a steep gradient and erodes the river bed deeper rather than wider. A mature river will not have as steep a gradient since it has been worn down over time and will erode the river bed wider rather than deeper. A river that does not cause very much erosion and has a low gradient is an old river.

Acid precipitation is caused when air pollution reacts with water in the atmosphere. Nitrogen oxide and sulfur oxide are released when fossil fuels are burned. These gases react with water to form nitric acid and sulfuric acid. These acids then make precipitation more acidic than normal. This makes the concentration of acid precipitation more than natural water. Acid precipitation is a cause of chemical weathering. Acid precipitation also has a negative effect on the environment. Soils can lose nutrients that are stripped away from acid precipitation which will affect plant growth. Aquatic ecosystems can be harmed or destroyed due to the pH of the water being changed by acid precipitation. Air pollution needs to be controlled to lessen the effects of acid precipitation on the environment. This could include scrubbers on factory stacks which reduce air pollution emissions and people using less fossil fuel in cars and transportation.

Student Demographics

This unit on weathering and erosion was taught at Holt Junior High School; the Holt community is a suburb of Lansing, Michigan. The community is fairly conservative. Holt Junior High School contains grades seven and eight with approximately 958 total students at the Junior High and approximately 477 students in the seventh grade. Of the students in seventh grade, approximately 77% were Caucasian, 8% African American, 7% Hispanic and 6% Multiracial.

Students at the junior high school come from a wide range of socioeconomic backgrounds. Some parents are employed by General Motors or other industrial factories. Other parents are professionals and work for the State of Michigan or Michigan State University. Almost 20% of the students come from economically disadvantaged households. These students have several programs to help them be successful including tutoring programs, mentoring programs and an at-risk coordinator for the junior high school.

Seventh graders at Holt Junior High School are placed on a team of 4 to 5 teachers. This team of teachers includes a language arts, social studies, mathematics and science teacher as well as a special education teacher. A student's schedule is made up of six 55 minute periods. Students are required to take year long courses in language arts, social studies, mathematics, and science. The student's fifth period is academic and includes topics such as health and keyboarding. A student's sixth period is an elective in which students may take band, choir, gym, engineering, and art.

Students participating in this study were in 4 separate science classes/hours. This science course is required of all seventh grade students with 109 students in these four classes. Ninety one students agreed to participate in the study and returned the consent form (Appendix A). Of these 91 students, 86 students' data were used. The five students that were not included had an attendance record of less than 75% for the unit. In the design of the project, it was stated students with less than 75% attendance would not be included in the study. Of the 86 students, 51 of the participants were girls and 35 were boys with a wide range of abilities and 12 special education students. Although these special education students were not identified as having problems in science, their skill level in reading, writing and mathematics hindered them in science class as well. A para-educator was present in two of the periods to help these special education students as well as low functioning students. The para-educator helped students with class work, hands-on activities, tests and organization.

The seventh grade science curriculum is divided into two primary topics, physical science and earth science. Each topic is taught in one semester. The physical science part of the course includes units on the scientific method, classification of matter, properties of matter, waves, sound, and light. The earth science part of the course includes units on weather and the atmosphere, water on earth, rocks and fossils, and surface features and changes. The weather and atmosphere portion is taught to students during the flex time. Flex time is an extra hour that students see teachers for a six week period for more instructional time in science, social studies, mathematics and language arts. This unit combined topics in water on earth and surface features and changes. These topics have many similar characteristics and seemed to fit together.

Implementation

The unit took place over 18 days in May, 2006. Holt Public Schools also had new science textbooks for 7th grade in the 2005-2006 school year. The textbooks were from *Holt Science and Technology for the middle grades.* Additionally for this unit we used the textbook, The Earth's Changing Surface. Activities were developed to coordinate with the new text and cover specific objectives identified by the school district. Prior to this school year, none of the hands-on activities included in this unit had been taught to students in my classes. The pre-test was given the first day of the unit before any material from the unit had been presented to determine prior knowledge. The post-test was given after students had completed the unit and all material had been presented. Activities were usually introduced after students had done some reading in their textbook about the concept. The following table shows the topics, objectives and coordinating activities for the unit.

Table 1

Topic	**Objectives** **Students will be able to:**	**Activities**
Weathering	• Define mechanical and chemical weathering • Give examples of mechanical and chemical weathering • Differentiate between mechanical and chemical weathering.	• Mechanical Weathering • Chemical Weathering • Chalk • Weathering & Erosion Outside at School
Erosion	• Explain the difference between weathering and erosion • Understand how various types of erosion move sediments	• Wind Erosion • Weathering & Erosion Outside at School

Table 1 continued

Topic	**Objective** **Students will be able to:**	**Activities**
Sediment Deposition	• Classify different types of sediments • Explain how different types of sediments are deposited • Rates of deposition	• Sediment Deposition • Rates of Sedimentation • Stream Table
River Life Cycle	• Explain a river's life cycle • Discuss a river's gradient and velocity	• Stream Table
Assessment	• Compose a poem about weathering, erosion, acid precipitation or the rock cycle	• Poetry Assignment

Lab Activities and Qualitative Analysis

For laboratory activities, students were assigned to groups of either three or four students either by counting off students or having students pick a card which assigned them to a lab table. This resulted in students working in different groups for each activity. They were expected to help one another and to discuss and share ideas. Each student, however, was responsible for turning in their own activity paper passed out for each assignment to ensure students completed the work and participated in the activity. This also provided a way to determine an individual grade for each student.

1. Chalk Activity – Appendix C1

The first activity students participated in was the Chalk Activity. This activity was designed so students could determine the difference between mechanical and chemical weathering. In this activity, students were given two pieces of chalk, a Ball jar, water and vinegar to model weathering. This activity went relatively well except that some lab groups had trouble seeing the size differences and the pitting of the chalk that occurred with the vinegar. Students were asked what they would change about this lab and many thought weighing the chalk before and after shaking would be helpful. Students also suggested that they would like to see what would happen if more vinegar was added and if the chalk was shaken more times. In general students liked this activity and they could see the difference between mechanical and chemical weathering. When this activity is taught again, the determining the mass difference between the starting and ending chalk should be added.

2. Mechanical Weathering Activity – Appendix C2

Students next completed the Mechanical Weathering Activity, which showed the effect of mechanical weathering on limestone to students. Students were asked to shake limestone to determine the effects of mechanical weathering. Students found the limestone that had been shaken more was smaller and more rounded than the limestone which had not been shaken as much. Some students by the end of the activity only had one or two pieces of limestone left. They had to think about what had happened to determine where the limestone had gone. All groups had sediments in the bottom of their jars at the end of the activity. Students enjoyed this activity and the physical activity that went with it. There were a few broken jars due to the weakening of the glass as the limestone was shaken but this did not seem to affect the results of the activity. Students only had to be reminded to really shake the jar so they were able to see the effect of mechanical weathering on limestone.

3. Chemical Weathering Activity – Appendix C3

The Chemical Weathering Activity took place over several days involving the rusting of steel wool over time. Students added water and made observations each day they were in science class. After one week of observations, much of the steel wool was rusty was brittle and fell apart. This activity went well in that each group's steel rusted and students could see the effects of chemical weathering. Students also liked making observations on days when there was book work. In the future, students could find the difference in mass of the steel wool at the beginning and at the end of the activity.

4. Wind Erosion Activity – Appendix C4

The Wind Erosion Activity was done to show how sediments can be transported by wind. Students were given a large rectangular container with a mixture of top soil, sand and pebbles and blew on the mound of sediments with various amounts of force. During the 1st hour, the soil mixture was slightly moist and did not move all that well. Lesson plans were rearranged so that 4th, 5th and 6th hours could have a drier soil mixture. The next day, after the soil mixture had dried out the remaining hours completed the activity. This activity worked very well once sediments were dry.

5. Sediment Deposition Activity – Appendix C5

The Sediment Deposition Activity occurred next. Prior to beginning the Sediment Deposition Activity, students completed a chart listing different types of sediment including type of sediment, size and a description of the sediment. At the start of the activity, students were asked to answer some questions about sediments which were included in their activity handout. Then, students were given a clear cylinder with silt, sand, gravel, pebbles, and organic material in water. Students shook the cylinder and observed how the sediments settled. This activity was successful in that students could see how different types of sediments settled out, however they had a difficult time identifying the type of sediment in a layer. When it is taught again, it will be a two day activity. The first day will be an activity for students to classify sediments to in order to fill out the sediment chart that was done at the beginning of this activity. Students were confused about some of the sediment types based on the description. By having this as a two day activity, it should help students to describe the different types of sediments.

6. Stream Table Activity – Appendix C6

The Stream Table Activity and the Rates of Sedimentation Activity (Appendix C7) took place over 2 days. On the first day, half of the class completed the stream table activity and the other half worked on the rates of sedimentation activity. The next day, students completed the activity they had not done. This worked very well and students working on the rates of sedimentation could complete the activity with very little help from the teacher once the activity was explained.

The Stream Table Activity was mostly a demonstration with students helping with timing and measuring of the flow of a piece of Styrofoam. Students during this activity had to take measurements of how long it took a piece of Styrofoam to travel one meter and the stream bed's width and depth at the head, center and mouth of the stream as well as draw diagrams of the stream at various times. At various times during the water flow, erosion along the banks of the stream and deposition at the mouth of the stream was pointed out to students. Once all the measurements were taken, students had to calculate the form ratio for the head, center and mouth of the stream. This ratio was found by taking the depth of the stream at a given point and dividing it by the width of the stream at the same point. This ratio showed how the river became wider and shallower at the mouth over time. Students also had to calculate velocity from the trials they conducted. At the end of the activity there were questions for the students to answer. Some students had problems with the calculations. This may be because some of the students were poor math students or special education students but some revisions on the charts the students filled out could help eliminate some of these problems. For the velocity chart, a column with the distance could be added so students would have to fill out the distance the Styrofoam traveled. The chart only contained a column for time since the distance did not change. By adding a column it would make it easier for students to understand what measurements they need to calculate velocity. The other change to this lab would be to reverse the width and depth columns in the form ratio chart. Students really liked this activity and wanted to do it again. They did not like all of the calculations but with changes to the charts this attitude could be changed.

7. Rate of Sedimentation Activity – Appendix C7

The Rate of Sedimentation Activity was done concurrently with the stream table activity. For this activity students were given a 1,000 ml plastic graduated cylinder, a meter stick, stopwatch and four types of sediments: limestone pieces, pebbles, sand and topsoil. The students were to answer questions about the rate of sedimentation as well as possible errors which may have occurred. The students liked this lab and did not have problems with the calculations. This may be because the charts were set up so that the calculations were easier.

8. Weathering and Erosion at School Activity – Appendix C8

For this activity, students were taken to three locations outside of the school to look for weathering and erosion. Students had a sheet they took with them that had to be completed and turned in at the end of the hour. The first location was the teacher parking lot behind the school. The students looked for examples of mechanical and chemical weathering as well as erosion. Plants in cracks of the pavement, ant hills and cracks possibly caused by ice were all examples of mechanical weathering. Chemical weathering was shown where rocks in the asphalt were rusting. There was erosion taking place where grass was not growing and sediments could be seen around a sewer grate. Students had a hard time initially with finding examples but once they got started could see examples in many places. The second location students went to was the bus circle. They had to again find examples of mechanical and chemical weathering and erosion. The examples were similar to the examples in teacher parking lot. Students had fewer problems finding examples at this location. The last location students went to was by the front door of the school. There were similar examples at this location as well as new examples. Mechanical weathering was found in bricks possibly due to ice and lichens were on a limestone ledge. There was also weathering on a limestone plate. Students could not decide if it was mechanical or chemical weathering since some of the plate had fallen off. They decided it was both since acid rain could have possibly weathered the limestone but ice could get in the cracks and weather it as well. This activity helped students connect weathering and erosion to their own lives and they were amazed they could see these processes. They also liked being outside and learning about science as well. The only change to this activity would be to find different locations where weathering and erosion are occurring.

9. Poetry Assignment – Appendix C9

A Poetry Assignment was the last activity students completed. This activity was originally going to be reading a picture book about the life of a river and having students write a story about it. This activity changed after learning students were working on a poetry unit in language arts. For the start of this activity, students were read the picture book, Science Verse (2004) by Jon Scieszka and Lane Smith. This book has poetry about science set to familiar poetry as well as new original poetry. The assignment was for students to write a poem about the rock cycle, acid precipitation or weathering and erosion. The rock cycle was included in this assignment because it related to what students had been studying prior to this unit. The poem had to include evidence they learned something about the topic they chose as well as a poetic device, a color illustration and a title. Poems students had used in language arts were also discussed to help give them ideas. The assignment did not specify the type or length the poem should be or what type of poetic device had to be used. Students had already learned about poetic devices and different types of poems in language arts so this did not need to be taught. As an extra bonus for the students, the grade students earned was also used for their grade in language arts class. Students were given this assignment on Thursday and expected to turn it in the following Monday. They were given the remainder of the hour to work on their poem. The Monday the poem was due, students took their post-test for this unit. After all of the tests had been completed students were given the opportunity to read their poetry to the class for extra credit. Thirty out of the eighty six students read their poetry to the class. Students really liked this assignment and how it related (and counted!) to language arts. They also liked hearing other student's poems. This assignment will be done again next year regardless of what science unit is being taught when the language arts class is working on their poetry unit.

Results

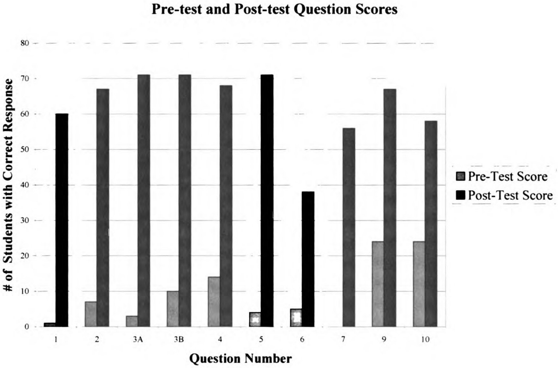
Effectiveness of the unit was determined by an assessment that was both a pre-test and post-test. The test and rubric are in Appendix B. The pre-test also determined student prior knowledge as well as any misconceptions they may have had and consisted of 10 open ended questions. The post-test also served as the unit test. For the post-test only 9 of the 10 questions were graded since there was not time to complete the glacier part of the unit, the subject of the tenth question.

Both the pre-test and the post-test were based on 11 points. The average score on the pre-test was 1.1 points or 10% with a range of 0 to 5 points. Most students did not know any of the material to be taught in the unit. The post-test average score was 7.7 points or 70% with a range of 1 to 11 points. Student pre-test and post-test scores were analyzed using a paired t-test. The probability of this result was 0.000 with a t-value of -31.5 and 85 degrees of freedom. This indicates that the probability of the two sets of data being the same is zero.

The pre-test and post-test scores for the 10 individual questions were compared for students with various academic abilities. High achieving students (n=23) almost always have completed work that shows they understand concepts, answer questions in depth and go above the requirements for a given assignment. Average achieving students (n=38) usually have completed work in but may not always understand the concepts, will answer questions with a few details and meet the requirements for a given assignment.

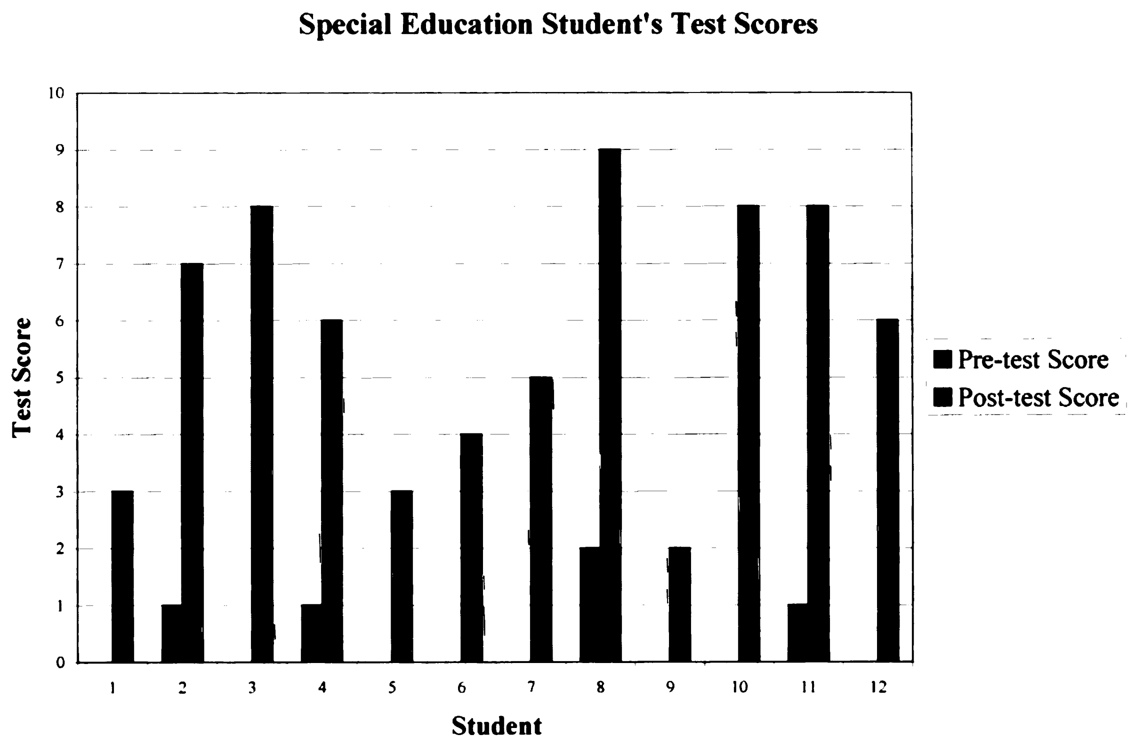
Low achieving students (n=25) might have completed work but do not understand the concepts, will answer questions with minimal effort and may or may not meet the requirements for a given assignment. For all of the questions, there was improvement from the pre-test to the post-test in all three groups. Individual questions will be addressed in the following paragraphs. Figure 1 shows the questions on the pre-test and post-test with the number of students with correct responses.

Figure 1



Special education student pre-test and post-test scores were analyzed as a sub group. There were 12 special education students that participated in the study. The students had a wide range of abilities and all were learning disabled with the exception of one cognitively impaired student. The students in general are low achieving but work very hard. This translates to good classroom work but low test scores. On the pre-test, the average score was .42 point or 3.8% with a range of 0 to 2. For the post-test, these students an average score of 5.75 points or 52% with a range of 2 to 9 (Figure 2).

Figure 2



These scores are below those of the whole group average but consistent with how this group preformed on tests throughout the year. All of the special education students improved their scores.

Item Analysis

For the first question (Q1) on the both of the tests, students were asked to give a definition of mechanical weathering. The question 3A (Q3A) on the tests, asked students to give an example of mechanical weathering. On the pre-test, only 1.2% of the students could give a definition of mechanical weathering and 3.5% of the students could give an example of mechanical weathering. When students took the post-test, 69.5% of the students could give a definition and 82.6% of students could give an example of mechanical weathering. This shows most students understood the concept of mechanical weathering. Most high achieving students got both of these questions correct. On the pre-test, one high achieving student stated as a definition, "Mechanical weathering is the regular weather caused by the water cycle or temperatures". The example the student gave was "blizzard". This was a common conception students had about weathering. Students thought it was related to weather in the atmosphere. Another common conception was,"where a machine helps break down rocks". For the post-test definition which this student answered, "Mechanical weathering is the breaking down of rocks by force or physical means" and the example was, "rocks sliding down a hill and grinding into each other". Most average and low achieving students could correctly give an example of mechanical weathering but some had problems with definition. One low achieving student could not state the definition in the pre-test or post-test but could give an example, "rock slide" of mechanical weathering. This was also true of special education students. Most students tended to give correct responses from examples done in activities such as "a crack in the road", "shaking pebbles in a jar" or "rocks tumbling in a river".

Question two (Q2) on the tests was to give a definition of chemical weathering. For Question 3B (Q3B), students had to give an example of chemical weathering. On the pre-test, 7.7% of the students could give the definition of chemical weathering. Many of the students used a phase like "weathering caused by chemicals". Some students, 11.6%, were able to give an example of chemical weathering on the pre-test. For the post-test, 77.1% of students were able to give a definition of chemical weathering and 82.6% of students could give an example. Most high achieving students answered correctly for both of these questions. An example of a high achieving student's pre-test response is "Chemical weathering is weathering done by people". This was a common conception of all students. A response for the definition for many students of all academic abilities on the post-test was, "breaking down of rocks by chemical means". The majority of students used as an example of chemical weathering either put, "acid rain" or "rust". Based on these results, many students post-instruction could state the definition of chemical weathering and an even higher percentage of students could give an example of chemical weathering.

Question 4 (Q4) addressed wind and how it contributes to erosion. On the pre-test, 16.4% of the students had a correct response. Students that had a correct response were high achieving students. An example of a correct pre-test response was, "because wind can lift or move pieces of the rock…". The common conception on the pre-test responses was, “it helps the particles break apart”. This shows many students did not understand the difference between weathering and erosion. An example of this misconception can be shown by high achieving student that stated on the pre-test, “Wind can blow sand by a rock, which can eventually break down a rock.” The same student on the post-test stated, “Wind blows objects from one place to another place.” Based on the post-test responses, with 79.1% correct responses, students understood the difference between weathering and erosion. An example of an average achieving response on the pre-test was, “wind contributes to erosion by”. The same student had a response on the post-test of, “The wind moves sediments and other objects around.” Some low achieving students also understood the difference between weathering and erosion. An example of a very low achieving special education student pre-test response was, “if it is hot it will erosion (sic)”. This student’s post-test response was, “the wind is strong and if it contributes the sand it would be a meas(mess)(sic)”. Even though this post-test response is not stated very well, the student does have a basic understanding of erosion and wind blowing sediments.

The Question 5 (Q5) on the pre-test and post-test asked for an example of weathering around the school. On the pre-test, 4.7% of the students stated a correct response. For the post-test responses, 82.6% of students had a correct answer. This question was directly related to the outside activity about weathering and erosion. Many high achieving students had responses with very specific examples such as, “you can see erosion around the school on any places with little or no grass”. Average and low achieving student responses were vaguer and did not give specific examples. An example of an average student's response was, "outside in the grass". A low student's response was, "by a sidewalk". All of these answers were considered correct. This question will be changed when given on a test in the future to give a specific example for erosion and also to give a specific example for weathering. Most of the students had a better understanding of where weathering and erosion occur in the world around them.

The pre-test and post-test Question 6 (Q6) was about sediments and how they would settle. Only 5.8% of students had a correct response on the pre-test. Average and low achieving students gave correct responses for the pre-test so it is possible they guessed at the correct answer. This was shown by one student having a correct response on the pre-test by listing, "silt, sand, pebbles, gravel" and changing the order of this list on the post-test, "gravel, pebbles, silt, sand". Only 44.2% of the students gave a correct response on the post-test. Some high achieving students gave very detailed, specific responses such as, "First the gravel will settle out, and the pebbles, and then the sand and then the silt. They settle out according to weight and density and the sand and silt will fill up the cracks." Average and low achieving students tended to just list the sediments. Many students did not list the sediments in order but discussed density based on their previous knowledge. This may because density was taught to these students at the beginning of the school year. An average student's response was, "They will settle out by density and size." The most common error on this question was students listing sand as being on top and silt below sand. Students did not understand the difference between sand and silt. This may be due to students filling out their sediment chart but not having examples to examine. Many students also drew a picture for this response. The same error was made in the picture responses of switching sand and silt. In the future, students will have examples of the different sediments when they fill out their charts.

Question 7 (Q7) on the pre-test and post-test asked students to explain a river's life cycle. On the pre-test, no student gave a correct response and many students left the question blank. Of the students that responded, many were about the water cycle. Examples of this are, "It is just like the water cycle" and "It is evaporated then precipitates and runs down back into the river". The post-test had 65.1% of students reply correctly. Most high achieving students gave detailed responses that were consistent with what they saw when they did the stream table activity. Some examples of high achieving student responses include, "First you would have a neat narrow stream in the sand. After a while erosion happens to the sides of the stream carrying the sand down into the mouth. The stream gets wide and steep after a period of time" and "Rivers start out as a small stream or river and weather the ground around them. The river widens and deepens and can start a second path." Average achieving students had correct responses with some details and also used the stream table activity. Examples of an average students response are, "A river spreads over land and takes sediments with it so that's how it gets wider" and "the river starts as a little stream and as the years go on the sides increase in size and the mouth or bottom of the river is larger than before". Low achieving and special education students did not have very many details but could give some correct information. A low achieving student response was, "It starts off as a stream then it breaks down the side and widens". Many special education students also had correct answers and some details. Examples of correct responses included, "It starts by going to one (sic) the stream is small and will grow over time by eroding the sand, rock, or gravel and carrys (sic) it to the mouth by the lake or ect(sic)" and "river would start off with a thin path but as it gets older the path gets bigger and sometimes make more paths". Most students had a better understanding of rivers and erosion at the end of this unit. The question was very open ended and lots of different answers were accepted. On a future test, this question will be broken down into several more specific questions.

The last two questions were about acid rain. Question 9 (Q9) asked students how acid precipitation formed and what it does to the environment. This question was graded using two points, one point for how acid precipitation is formed and one point for what it does to the environment. On the pre-test, 16.7% of the students replied correctly. Students only earned one point for answering part of the question. The students that earned a point usually answered about the environment. A high achieving student's response on the pre-test was, "Acid precipitation is caused by pollution. It dizzloves(sic) marble and makes the ground unsoutable (sic) for plants". A typical average achieving response on the pre-test was, "Acid precipitation hurts the trees and forest." High achieving students tended to answer both parts of the question while average and low achieving students only answered part of the question. Examples of high achieving responses include, "When pollutants get in the atmosphere they make the clouds acidic causing acid precipitation, which is damaging to all life" and "Acid precipitation is formed when molecules of water in the sky mix with acids and chemicals in the air and then fall to the earth. It breaks down the environment and is bad for plants and animals." Some high achieving students answered the question with only one part of the question being addressed but with good details. An example of this was, "Acid precipitation is formed by pollution in the air raising the pH scale, fusing with the precipitation causing acid rain." Some average achieving students answered both parts of the question but did not have as many details such as, "Acid precipitation is formed by vehicle exhaust and the pollution from factories/buildings. Acid precipitation burns the trees." Low achieving students tended to answer just one part of the question. Examples of a low achieving student's responses are, "it breaks down materials outside" and "pollutes the environment and the animals around it". Most students received at least one point for this question. The students that did not have correct responses tended to be low achieving. Since the question asked about two concepts, it probably should have been made into 2 parts.

The last question (Q10) also dealt with acid precipitation and asked students what people can do to help control acid precipitation. This question on the pre-test had the highest number of correct responses, 27.9%. An example of a correct pre-test response from a high achieving student was, "people can help by not using things that pollute the air". Many students that had a correct pre-test response had a more detailed post-test response. An average achieving student's response on the pre-test was, "help clean up the air". The same student's post-test response had more details, "They can put scrubbers on the smoke stacks and control the amount of gases". On the post-test, 67.4% of students answered correctly. High and average achieving students tended to have more details as seen from the previous example. Lower achieving students had less detailed examples which included, "they could walk more, use citys (sic) transportation" and "slow and clean air pollution". Students did fairly well on both of the acid precipitation questions even though there was not a related hands-on activity. This may be because during a unit on the weather and the atmosphere, acid precipitation was discussed.

Activities

Results were also examined for the various activities students completed for the unit. Most of the students did well on the activities. Students were graded on activities based on points. Points were given for having answers in complete sentences, diagrams being drawn with labels and calculations. The *Chalk Activity* had the lowest average percentage, 88%. Table two shows each activity with the points possible, range, and average score and percentage. Activities and rubrics are contained in Appendix C.

Table 2

Activity	Average Point Score	Total Points Possible	Average Percentage	Low Score	High Score
Chalk Activity	26.4	30	88%	21	30
Mechanical Weathering Activity	33.9	36	94%	26	36
Chemical Weathering Activity	30	32	94%	25	30
Wind Erosion Activity	27.6	30	92%	25	30
Stream Table Activity	29.75	32	93%	28	32
Sediment Deposition Activity	28.8	31	93%	23	31
Rate of Sedimentation Activity	32	34	94%	28	34
Weathering and Erosion at School	16.2	18	90%	11	18
Poetry Activity	46.5	50	93%	10	60

Average and low achieving students tended to have better activity scores than post-test scores. These students also tended to have better class work and activity scores than test scores throughout the year. This may be due to them working with other students and not having to recall information in a test setting.

The first set of activities concentrated on weathering. There were 3 activities that dealt with weathering, *The Chalk Activity* (Appendix C1), *The Mechanical Weathering Activity*

(Appendix C2), *and The Chemical Weathering Activity* (Appendix C3). Students were able to distinguish the difference between mechanical weathering and chemical weathering in the chalk activity. A question in the activity asked students which type of weathering might do more damage based on their results. An average achieving, student answered, "the water and vinegar did more damage because it has more acidity". Almost all students at the end of the activity could tell the difference between mechanical and chemical weathering. During classroom discussion at the end of the activity, many students had suggestions on ways to extend the activity. Suggestions included adding more vinegar, shaking the jar more, and taking the mass of the chalk before and after shaking. Students had an average of 94% on the mechanical weathering activity and were able to predict outcomes based on the activity. In the activity, students were asked what would happen if a harder rock was used in the activity instead of soft limestone. Higher achieving students had responses such as, "If you used granite the jar might break or the rock wouldn't change much" and "If you used a harder rock such as granite in this lab it will take much more powerful shakes or faster shaking". Average and low achieving students has less detailed responses of, "you would have to shake the rock harder and longer" and "not a lot of change". The chemical weathering activity had students look at steel wool with water over time. Students enjoyed looking at their steel wool over a period of about a week. A question in the activity asked students to relate the rusting of steel wool to the weathering of rocks. Most students were able to make this connection. This was shown by average and low achieving student responses such as, "because rocks brake (sic) down like the wool" and "These changes relate to rock weathering because some rocks rust because they have iron". Based on the activity (94%) and post-test results (82.6%), most students had some knowledge of weathering.

The Wind Erosion Activity (Appendix C4) *and The Stream Table Activity* (Appendix C6) dealt with erosion. Students did well with an average percentage of 92% on the wind erosion activity and had a better understanding of how wind can displace sediments and soils. The activity asked a question about how farmers could protect topsoil from wind erosion. High achieving students usually had at least two suggestions such as, "They should not plant crops at the top of hills and not cut their crops in rows that go up the mountain. No till farming might help too" and "They would have to pack the soil down and put it flat so it won't blow away. Or you could grow cover crops". Low achieving students usually had just one suggestion such as, "Plant (sic) will keep the soil down" or "keep the ground as flat as possible". Students were also asked where in Michigan they might see wind erosion. A typical response for a high achieving student was, "You can see them on sand dunes, small mountains/hills, outside sports fields, beaches". Responses from low achieving students had just one example such as, "on the beach" and "the sand blow other place(sic)" from a special education student. The stream table also illustrated erosion caused by water. Students were able to answer the erosion question contained within the activity about how erosion in a stream occurs. High achieving students had responses with more details such as, "Erosion occurs by the water making the sides of the ground break down into the water. This occurs on the sides and bottom and is deposited at the mouth" and "Pieces of sediment are broken off by erosion on the banks and bottom, making the stream wider and deeper." Average achieving students also had responses with some details, "The water erodes the sand on the side, after a while they collapse in and the river grows". Lower achieving students had simpler responses such as, "from the water on the sides of the banks" and "The movement of the water does the erosion in the stream". A few lower achieving students, however, were still confused about the difference between weathering and erosion, "by moving sand against larger stones and making them smoother and smoother". Overall, students understood erosion and the agents that cause it.

There were two activities about sediments and deposition. In *The Sedimentation Deposition Activity* (Appendix C5), students had to observe how different sediments settled out. Students were able to correctly draw a picture of how sediments settled in a tube. High achieving students written observations included, "The water is cloudy with silt and clay. The largest of the sediments are at the bottom. The smallest sediments are at the top." and "Gravel is on bottom, sand on top of the gravel, silt and clay were suspended". Average and lower achieving student observations tended to be less specific and not about the sediments. Some examples of these types of responses are, "The sediments pile on each other", "they all mixed together. It was a darker color. Then the gravel settled at the bottom" and "The sand and water never mixed. The gravel was always on the bottom. The water was always on the top." These observations may explain why average and lower achieving students did not do very well on the post-test question related to this and mixed up sand and silt. These students also had difficulties with making good observations in other activities throughout the year. They have a hard time documenting important observations versus random observations. The second activity was *The Rate of Sedimentation Activity* (Appendix C7). Students had to record the time it took various sediments to settle. Students tended to do better on this activity as compared to the Sediment Deposition Activity since it was quantitative instead of qualitative. Students could calculate the rate of sedimentation and make comparisons between the different types of sediments.

For *The Stream Table Activity* (Appendix C6) students looked at a stream/river's life cycle and its characteristics such as velocity, stream depth and width and erosion. Students were asked to explain how the river changed from start to finish. Higher achieving student responses had more details than did those of average and lower level students. Some examples of their responses are: "The river kept getting wider, eroding the banks and pushing the sediments towards the end of the river" and "The river got wider by erosion and less deep at the mouth. Plus it moved". Average achieving student responses varied from having adequate details to very few details, "The water erodes the sand on the side. After a while they collapse in and the river grows" and "The river changed by going faster." Lower achieving student responses tended to have only one detail such as, "it got wider", "it got bigger and the river walls eroded" and "there were little paths". These observations may explain why average and lower achieving students did not respond properly to the river life cycle question on the post-test. Students also had problems with calculating the velocity of the stream and the form ratio. These students were also usually lower achieving students. This problem could be avoided by changing the charts students fill in for the calculations. By doing this, these students would probably be able to properly execute the calculations.

At the end of the unit there was one activity, *Weathering and Erosion at School* (Appendix C8), to show students weathering and erosion in everyday life. Students were taken outside to three different sites and asked to write down examples of mechanical weathering, chemical weathering and erosion. At the first site, students had some problems with finding weathering and erosion. After approximately 10 minutes, the teacher went over examples of weathering and erosion. This helped students greatly and at the next two sites they did not have many problems finding examples. Most of the students did well on this activity. Students were surprised that some examples did not fit into just one weathering mechanism. An example of this was cracks in the pavement. These cracks could be caused by two types of mechanical weathering, ice expansion as well as plants growing in them. Another example is a sign on the front of the school that had a piece cracked off. Students were able to say it could be mechanical weathering due to ice or chemical weathering from acid rain. High achieving students tended to write more than average and low achieving students, but these latter students had the correct information on their sheet. This activity was very successful and students greatly enjoyed being outside on a nice spring day. The majority of students could also give examples of mechanical and chemical weathering on their post-tests.

The last activity students completed was an assessment of writing a poem, *Science Poetry* (Appendix C9). The poem could be about weathering, erosion, acid rain or the rock cycle. The rock cycle was not taught as part of this unit but was completed just prior to the start of this unit and related well to content that was taught in this unit. Of the 86 students that participated in this study, 76 students submitted a poem. The 10 students that did not turn in a poem were average and low achieving students that did not always turn in work. The average score for students that turned in a poem was 45.6 points out of a possible 50 points. The assignment and rubric are in Appendix C. The range of scores was from 10 to 60 points. The maximum score was 60 points because students could earn 10 additional points for reading their poem to the class. Thirty students earned the additional points. Low achieving students received higher scores on their poem than they did on the post-test. For example, one of the lowest achieving students that only earned 1 point on the post-test received 45 points on the poem. Higher achieving students usually had good poems but may not have included an illustration or enough science content in their poem. An example of this is a high achieving student that earned 11 points on the post-test but only earned 40 points on the poem due to not having an illustration. Examples of student's poems are shown in Appendix D. This activity was very successful since all students could have earned a good score. Students appeared too really like this activity/assignment and wanted to write more poems.

Discussion and Conclusion

The purpose of this unit was to identify objectives in the Earth Science portion of Holt Public Schools seventh grade science curriculum. These objectives were:

1. All students will describe and explain how the earth's features change over time.
2. All students will describe how water moves.
3. All students will analyze effects of technology on the earth's surface and resources.
4. All students will analyze the relationships between human activities and the atmosphere.

The next step was to design hands-on activities that related to these objectives. Seventh grade students are in cognitive transition. According to Piaget, they are concrete operational thought processes transitioning to formal operation thought processes. As a result, these students need concrete examples and activities to help master new material and abstract ideas. These activities also are important for students becoming scientifically literate. For the activities in this unit, students had to respond in complete sentences and effectively communicate about the science material they were learning. The questions in these activities also had students take the material they were learning and apply the concepts to new situations. The skill of transferring knowledge is an important part of becoming a scientifically literate individual. The students also had to make connections to their own life which is important for scientific literacy. Hands-on activities also help with student interest and promoting positive attitudes about science. Literature and writing also promote scientific literacy. By being able to take the concepts they had learned in this unit and write poetry, students were able to creatively take the information and show mastery of the subject. The activities in this unit were designed to try and incorporate all of these factors. Students were successful in mastering the instructional material of this unit as evidenced by the comparing the pre-test and post-test scores. Test analysis shows the pre-test had an average of 10% whereas the post-test had an average of 70% which is significantly higher.

This was the first time all of the activities had been taught. There will be, however, some changes made. The weathering portion of this unit had three activities: *the Chalk Activity, Mechanical Weathering Activity and Chemical Weathering Activity. The Chalk Activity* will need some changes. Students will have to weigh the chalk before and after they have weathered it which should then help them see the difference between mechanical and chemical weathering. *The Mechanical Weathering Activity and Chemical Weathering Activity* went very well since student activity scores were both above 90%. Students also were able to correctly answer the questions about weathering on the post-test. These two activities will not be changed since they seemed to help students understand the concepts of mechanical and chemical weathering.

The erosion portion of the unit had two activities. *The Wind Erosion Activity* seemed to help students understand this concept and no changes need to be made to it. This portion of the unit does need to be expanded since other types of erosion were not presented in this unit due to time constraints. Erosion by glaciers and wave action were not addressed. In the future, the stream table will be utilized to demonstrate these two important concepts and related activities will be developed. The second activity, *Weathering and Erosion at School*, went well since students could give examples of weathering and erosion the post-test. Students were surprised to learn that weathering and erosion were happening around them. This helped them connect these two concepts with their own lives. This activity could include other sites around the school for students to examine or have a follow up homework assignment for students to identify weathering and erosion around their homes. This activity also helped students distinguish the difference between weathering and erosion.

The Sediment Deposition Activity will need to have more time given the classification of sediments since only about 43% of the students gave a correct response on the post-test. An activity having students identify different sediments will need to be developed. This having an activity based just on types of sediments, students should be better able to answer questions about them. This would also be useful when teaching students about glaciers and the types of materials they deposit. *The Stream Table Activity* was one of the student's favorite activities even though much of it was a demonstration. In the future, student groups should be smaller so each student can be a more active participant. Data tables need to be changed so students will have an easier time with the calculations. More time also needs to be given to discussing rivers and the terminology used with them. This is important so that students can accurately describe what they are observing during the activity. Students during this activity had questions about terminology and this should help them better understand these terms as well as river life cycles. This will be done in the future so *The Stream Table Activity* is more meaningful for students.

The Science Poetry assignment was also very successful as evidenced by students poems with an average 91%. Students enjoyed being read Science Verse and found it to be very funny. This activity was developed to encourage writing across the curriculum and coordinated with the poetry unit that was being taught in the student's language arts class as well. It was exciting to see how creative students were as well as seeing what they had learned. This activity will be included in future years when students are working on poetry in language arts class regardless of what science is being taught at the time. There do however, need to be additional writing assignments for this unit. These could include writing a story about the life of glacier or how a rock undergoes weathering, erosion and deposition. There is not enough time given to writing currently in science class. Writing is important for students since it promotes science literacy as well as helps teachers learn what students know.

Students enjoyed this unit and the activities that went with it. The students worked hard and learned a great deal from the activities as seen in the post-test scores. There was a wide range of abilities in this group of students and all students seemed to be challenged. High achieving students had detailed answers with examples on the activity and post-test questions. These students also had suggestions on how to improve activities and were able to determine what else they would like to learn about a concept. Average achieving students also could answer questions on the activities and post-test and could give some details and examples of the concepts. Lower achieving and special education students also seemed to be able to understand concepts as seen in the post-test scores of the special education subgroup. In the future, this unit needs to be expanded and have some modifications for the activities taught.

APPENDIX A

Parent and Student Consent Form
Collection of Data for Master's Thesis Research
Teaching Weathering and Erosion with an Emphasis of Hands-on Activities to Middle School Students

Dear Parent/Guardian and Students:

This term I will be teaching a unit on erosion and weathering. I have developed this unit as the major portion of my Master's thesis at Michigan State University. The students will actively learn about soils, factors effecting erosion such as moving water, wind and glaciers and environmental issues. An important part of my thesis research will be collecting information on the effectiveness of the unit which then will be used in my thesis.

In order to complete this thesis research, data will need to be collected from pre and post tests, quizzes, laboratory activities, and surveys. With your permission I would like to include your child's data in my thesis. The time your child would participate in this research would be normal class time and any homework they may have during the unit. There are no known risks associated with participation in this study. Students will have the benefit of learning the required curriculum with hands on activities regardless of whether they participate in the study or not. Your child's privacy will be protected to the extent that is allowable by law, and at no time will the student's name be used or connected to any part of my thesis paper. All data will remain confidential.

Participation in this study is voluntary. You may choose not to participate at all. Your child will not be graded any differently should you not want your child to participate in this study. Students will be expected to participate in classroom activities and complete assignments whether you allow their data to be included in the study or not. The only difference would be their data would not be included in my thesis work. At any time during the unit you may request your child's information not be included and your request will be honored.

Please complete the attached from and return it to me by May 15, 2006. Should you have any questions, I can be contacted at Holt Junior High

School, 699-7655 or by email at nmcgaugh@hpsk12.edu. If there are any questions about the project for my thesis advisor, please contact Merle Heidemann, Ph.D., Division of Science & Mathematics Education, (517)432-2152, email heidem2@msu.edu. If there are any questions that you have about your rights as a study participant, please contact Peter Vasilenko, Ph.D., Director of Human Research Protections, (517)432-4503, email irb@msu.edu, 202 Olds Hall, Michigan State University, East Lansing, Michigan 48824-1047.

Thank you,
Nicole McGaugh - 7^{th} grade science teacher, Holt Junior High School

I voluntarily agree to have ______________________ participate in this study. (print student name)

Please check all that apply.

Data:

______ I give Mrs. McGaugh permission to use data generated from my child's work in this class. All data from my child shall remain confidential.

______ I do not wish to have my child's work used in this thesis project. I acknowledge that my child's work will be graded in the same manner regardless of their participation.

Parent/Guardian Signature________________________ Date:_________

I voluntarily agree to participate in this thesis research project.

Student Signature_____________________________ Date:__________

APPENDIX B

Name:________________
Hour:__________________

Weathering and Erosion
Pre-Test

1. What is mechanical weathering?

2. What is chemical weathering?

3. Give an example of :
   Mechanical weathering:

   Chemical weathering:

4. How does wind contribute to erosion?

5. Where can you see examples of erosion around the school?

6. If there is sand, silt, pebbles and gravel in a jar, how will these materials settle out?

7. Explain a river's life cycle.

8. How do glaciers transform the land?

9. How is acid precipitation formed and what does it do to the environment?

10. What can people do to help control acid precipitation?

Name: Key

Hour: ____________

Weathering and Erosion
Pre -Test

1. What is mechanical weathering?

   Mechanical weathering is the breaking down of rock by physical means.

2. What is chemical weathering?

   Chemical weathering is the breaking down of rock by chemical means.

3. Give an example of :

   Mechanical weathering:

   Rocks being shaken in jar, plant roots, ice expanding in a crack, etc.

   Chemical weathering:

   Acid rain, caves being formed, rust, etc.

4. How does wind contribute to erosion?

   Wind contributes to erosion by blowing sediment such as sand and topsoil away.

5. Where can you see examples of erosion around the school?

   Erosion can be seen in places without grass/groundcover.

6. If there is sand, silt, pebbles and gravel in a jar, how will these materials settle out?

   Gravel would be on the bottom, pebbles would be on top of the gravel, sand would be on top of the gravel and silt would be on the top.

7. Explain a river's life cycle.

   A river starts out thin and widens due to erosion. Sediment is carried down the river to the mouth were it is deposited. The velocity of the river increases. The river becomes shallower and wider as time progresses.

8. How do glaciers transform the land?

   Not answered

9. How is acid precipitation formed and what does it do to the environment?

   Acid precipitation is formed by air pollution from the burning of fossil fuels. This air pollution combines with water and produces acid so precipitation becomes more acidic. Acid precipitation causes problems with ecosystems, and the faster weathering of monuments.

10. What can people do to help control acid precipitation?

    People can not burn as many fossil fuels and walk or ride a bike. Factories can install scrubbers to control the output of air pollution.

Name:_______________

Hour:________________

Weathering and Erosion
Post -Test

1. What is mechanical weathering?

2. What is chemical weathering?

3. Give an example of :

   Mechanical weathering:

   Chemical weathering:

4. How does wind contribute to erosion?

5. Where can you see examples of erosion around the school?

6. If there is sand, silt, pebbles and gravel in a jar, how will these materials settle out?

7. Explain a river's life cycle.

8. How do glaciers transform the land?

9. How is acid precipitation formed and what does it do to the environment?

10. What can people do to help control acid precipitation?

Name: Key

Hour:

Weathering and Erosion
Post -Test

1. What is mechanical weathering?

   Mechanical weathering is the breaking down of rock by physical means.

2. What is chemical weathering?

   Chemical weathering is the breaking down of rock by chemical means.

3. Give an example of :

   Mechanical weathering:

   Rocks being shaken in jar, plant roots, ice expanding in a crack, etc.

   Chemical weathering:

   Acid rain, caves being formed, rust, etc.

4. How does wind contribute to erosion?

   Wind contributes to erosion by blowing sediment such as sand and topsoil away.

5. Where can you see examples of erosion around the school?

   Erosion can be seen in places without grass/groundcover.

6. If there is sand, silt, pebbles and gravel in a jar, how will these materials settle out?

   Gravel would be on the bottom, pebbles would be on top of the gravel, sand would be on top of the gravel and silt would be on the top.

7. Explain a river's life cycle.

   A river starts out thin and widens due to erosion. Sediment is carried down the river to the mouth were it is deposited. The velocity of the river increases. The river becomes shallower and wider as time progresses.

8. How do glaciers transform the land?

   Not answered

9. How is acid precipitation formed and what does it do to the environment?

   Acid precipitation is formed by air pollution from the burning of fossil fuels. This air pollution combines with water and produces acid so precipitation becomes more acidic. Acid precipitation causes problems with ecosystems, and the faster weathering of monuments.

10. What can people do to help control acid precipitation?

    People can not burn as many fossil fuels and walk or ride a bike. Factories can install scrubbers to control the output of air pollution.

APPENDIX C

Name:________________
Hour:________________

Chalk Lab

Purpose: The purpose of this lab is to introduce the effects of mechanical and chemical weathering on chalk.

Manipulated Variable:

Responding Variable:

Control Variables:

Hypothesis:

Procedure:

1. Break one piece of chalk into 3 approximately equal pieces.
2. Measure 400 mL of water into jar.
3. Place chalk into jar.
4. Shake jar with chalk and water approximately 100 times.
5. Take chalk out of jar and answer questions in the results section.
6. Break another piece of chalk into 3 approximately equal pieces.
7. Measure 300 mL of water and 100 mL of vinegar into jar.
8. Place chalk into jar.
9. Shake jar with chalk, water and vinegar approximately 100 times.
10. Take chalk out of jar and answer questions in results section.

Results:

1. Draw and label a picture of the chalk before it is put in the jar with water.

2. What does the water look like after it has been shaken with chalk?

3. What does the chalk look like after it has been shaken with the water?

4. Draw and label a picture of the chalk after it has been shaken with water.

5. What does the water and vinegar solution look like after it has been shaken with chalk?

6. What does the chalk look like after it has been shaken with water and vinegar solution?

7. Draw and label a picture of the chalk after it has been shaken with the water and vinegar solution.

Conclusions:

1. What type of weathering does the water and chalk represent? Why?

2. What type of weathering does the chalk, water and vinegar represent? Why?

3. How does vinegar change what happens to the chalk?

4. Which type of weathering does more damage based on this lab? Why do you think this is?

5. If you shook the jar more, what do you think would happen to the chalk?

6. How did your results compare with your hypothesis?

Name: *Key*
Hour:

Chalk Lab

Purpose: The purpose of this lab is to introduce the effects of mechanical and chemical weathering on chalk.

Manipulated Variable: *type of solution, water or water & vinegar*

Responding Variable: *the chalk, type of weathering*

Control Variables: *jar, beaker, number of shakes*

Hypothesis:

Example: If the chalk is in a water solution then it will weather less.

Procedure:

1. Break one piece of chalk into 3 approximately equal pieces.
2. Measure 400 mL of water into jar.
3. Place chalk into jar.
4. Shake jar with chalk and water approximately 100 times.
5. Take chalk out of jar and answer questions in the results section.
6. Break another piece of chalk into 3 approximately equal pieces.
7. Measure 300 mL of water and 100 mL of vinegar into jar.
8. Place chalk into jar.
9. Shake jar with chalk, water and vinegar approximately 100 times.
10. Take chalk out of jar and answer questions in results section.

Results:

1. Draw and label a picture of the chalk before it is put in the jar with water.

   Students need to draw and label a picture

2. What does the water look like after it has been shaken with chalk?

   The water should appear slightly cloudy.

3. What does the chalk look like after it has been shaken with the water?

   The chalk should appear smaller.

4. Draw and label a picture of the chalk after it has been shaken with water.

   Students should draw a label a picture.

5. What does the water and vinegar solution look like after it has been shaken with chalk?

   The water should appear cloudy.

6. What does the chalk look like after it has been shaken with water and vinegar solution?
   The chalk should appear smaller and have small pits.

7. Draw and label a picture of the chalk after it has been shaken with the water and vinegar solution.

Students should draw a picture and label it.

Conclusions:

1. What type of weathering does the water and chalk represent? Why?

   This is mechanical weathering since the pieces of chalk are rubbing against each other (abrasion).

2. What type of weathering does the chalk, water and vinegar represent? Why?

   This is chemical weathering since the vinegar is helping to dissolve the chalk.

3. How does vinegar change what happens to the chalk?

   The vinegar creates "pits" in the chalk and causes it to weather faster.

4. Which type of weathering does more damage based on this lab? Why do you think this is?

   The chemical weathering does more damage since the chalk is smaller. The vinegar is an acid which causes the chalk to weather faster.

5. If you shook the jar more, what do you think would happen to the chalk?

   If the chalk was shaken more, it should get smaller for both water and water/vinegar solutions.

6. How did your results compare with your hypothesis?

   Students should compare their hypothesis to the results in the activity.

Name:____________________
Hour:_____________________

Mechanical Weathering Lab

Purpose: The purpose of this lab is to determine how water will weather limestone.

Manipulated Variable:

Responding Variable:

Control Variables:

Hypothesis:

Procedure:

1. Collect 24 pieces of limestone, all approximately the same size.
2. Place 3 of the limestone pieces on the paper labeled 0 shakes.
3. Place the remaining 21 pieces of limestone in the jar.
4. Close the lid of the jar.
5. Shake the jar 100 times.
6. Remove 3 pieces of limestone and lay them on the piece of paper labeled 100 shakes.
7. Repeat the steps 4-6 until 700 shakes have been completed.

Results:

1. How does abrasion break down rocks?

2. Describe the surface of the rocks with 0 shakes. Are they smooth or rough?

3. Fill in the table below.

Number of Shakes	Description	Picture

4. Why did the rocks change?

5. How did the water change during the activity?

6. What would happen if you used a much harder rock, such as granite, for this experiment?

7. How do the results of this experiment compare to what happens in a river?

8. What do you think would happen if the rocks were shaken more?

9. How do your results compare with your hypothesis?

This lab was adapted from Holt, Rinehart and Winston Lab Rockin' Through Time, Weathering & Soil Formation

Name: Key

Hour:

Mechanical Weathering Lab

Purpose: The purpose of this lab is to determine how water will weather limestone.

Manipulated Variable: *Number of shakes*

Responding Variable: *size and shape of limestone*

Control Variables: *type of limestone, water, jar, method of shaking*

Hypothesis: *Example: If the limestone is shaken more, then there will be less weathering.*

Procedure:

1. Collect 24 pieces of limestone, all approximately the same size.
2. Place 3 of the limestone pieces on the paper labeled 0 shakes.
3. Place the remaining 21 pieces of limestone in the jar.
4. Close the lid of the jar.
5. Shake the jar 100 times.
6. Remove 3 pieces of limestone and lay them on the piece of paper labeled 100 shakes.
7. Repeat the steps 4-6 until 700 shakes have been completed.

Results:

1. How does abrasion break down rocks?

   Abrasion breaks down rocks by the rubbing against each other and scraping each other.

2. Describe the surface of the rocks with 0 shakes. Are they smooth or rough?

   The surface of the rocks is rough with jagged edges.

3. Fill in the table below.

Number of Shakes	Description	Picture
0	*Students should write a description with the rocks getting smoother over time.*	*Students should draw pictures of rocks with them getting smaller and smoother over time.*
100		
200		
300		
400		
500		
600		
700		

4. Why did the rocks change?

The rocks should become smaller and smoother.

5. How did the water change during the activity?

The water started out clear and then became cloudy as time progressed. There were also sediments in the bottom of the jar as more shakes occurred.

6. What would happen if you used a much harder rock, such as granite, for this experiment?

If a harder rock was used, then the rocks would not weather as much.

7. How do the results of this experiment compare to what happens in a river?

This is like what happens at the bottom of a river because rocks are constantly bumping and scraping against each other.

8. What do you think would happen if the rocks were shaken more?

If the rocks were shaken more, they should get smaller and smoother. There might also be more sediment at the bottom of the jar. If the rocks were shaken enough there would just be sediments in the jar.

9. How do your results compare with your hypothesis?

Students need to compare their hypothesis with their results in the activity.

This lab was adapted from Holt, Rinehart and Winston Lab Rockin' Through Time, Weathering & Soil Formation

Name:________________

Hour:_________________

Chemical Weathering

Purpose: To observe the chemical weathering of steel wool.

Manipulated Variable:

Responding Variable:

Control Variable:

Hypothesis:

Procedure:

1. Weigh a small piece of steel wool.
2. Place the piece of steel wool in a plastic container.
3. Measure 10 mL of water and pour it over the steel wool.
4. With masking tape, label your container with your lab group and hour.
5. Make observations over the next several days of what happens to the steel wool.
6. On the last observation day, weigh the steel wool again and record the mass.

Results:

What is the starting weight of the steel wool?

Day	Amount of Water	Description

What was the weight of steel wool at the end of your observations?

Why was the weight of the steel wool different?

How did the steel wool change over time?

How did the amount of water change over time? Where did the water go?

How do these changes related to rock weathering?

Where could you see an example of chemical weathering?

How do the results compare with your hypothesis?

Name: KEY
Hour:

Chemical Weathering

Purpose: To observe the chemical weathering of steel wool.

Manipulated Variable: *amount of time*

Responding Variable: *rust on the steel wool*

Control Variable: *container, steel wool, water, environment*

Hypothesis: *Example: If the steel wool is in water for a longer time, then there will be more rust on it.*

Procedure:

1. Weigh a small piece of steel wool.
2. Place the piece of steel wool in a plastic container.
3. Measure 10 mL of water and pour it over the steel wool.
4. With masking tape, label your container with your lab group and hour.
5. Make observations over the next several days of what happens to the steel wool.
6. On the last observation day, weigh the steel wool again and record the mass.

Results:

What is the starting weight of the steel wool?

Students should weigh the steel wool.

Day	Amount of Water	Description
Date	*10 mL*	*Students should describe steel wool with no rust.*
Date	*10 mL*	*Students should describe steel wool with some rust forming.*
Date	*10 mL*	*Students should describe steel wool with some rust forming.*
Date	*10 mL*	*Students should describe steel wool with more rust forming.*
Date	*10 mL*	*Students should describe steel wool with more rust forming.*
Date		*Students should describe steel wool with more rust forming.*

What was the weight of steel wool at the end of your observations?

Students should record ending weight of steel wool.

Why was the weight of the steel wool different?

There was more water added each day (10mL water = 10 grams) and the formation of rust.

How did the steel wool change over time?

The steel wool had more rust each day. The rust was brittle unlike the original steel wool.

How did the amount of water change over time? Where did the water go?

The water was added each day and it had a chemical reaction with the steel wool to create rust. Some of the water also might have evaporated.

How do these changes related to rock weathering?

Many rocks contain iron which will cause the rocks to rust. Also chemical weathering will break down rocks like the rust broke down the steel wool.

Where could you see an example of chemical weathering?

Examples could include: cars rusting, rocks rusting, cave formation

How do the results compare with your hypothesis?

Students should compare their hypothesis with their activity results.

Name:____________________
Hour:_____________________

Wind Erosion Lab

Purpose: To show how wind erodes soil, sand and pebbles.

Manipulated Variable:

Responding Variable:

Control Variable:

Hypothesis:

Procedure:

1. Put a handful of soil mixture (soil, sand and pebbles) in your bin.
2. Form a mountain at one end of the bin.
3. Draw a picture of the bin with the mountain before blowing.
4. Gently blow on the mountain with your straw. Record your findings.
5. Blow with slightly more force on the mountain. Record your findings. Be careful not to blow soil into anyone's face or out of the bin.
6. Blow with more force than the last time. Record your findings.

Results

1. Draw and label a picture of the bin with the mound before any blowing takes place.

2. Draw and label a picture after the bin and mountain after slight wind has blown.

3. Which material is scattered the most? Why does this happen?

4. Which material is scattered the least? Why does this happen?

5. Draw and label a picture of what happens when more wind is blown on the mountain.

6. Draw and label a picture of what happens at the end of the experiment. Draw arrows on the picture to show what happens what happens as wind hits the mountain.

Conclusions

1. What happened as more wind force was added to blow on the mountain?

2. What type of material was displaced the easiest?

3. What type of material took the most force to move?

4. What precautions would farmers have to take to protect their soil from wind erosion?

5. Where in Michigan can you see wind erosion?

6. How does wind affect sand dunes?

7. How do your results compare with your hypothesis?

Name: Key

Hour:

Wind Erosion Lab

Purpose: To show how wind erodes soil, sand and pebbles.

Manipulated Variable: *amount of wind force*

Responding Variable: *material being moved*

Control Variable: *sediment mixture, straw, person blowing*

Hypothesis: *Example: If the wind is stronger, then more erosion will take place.*

Procedure:

1. Put a handful of soil mixture (soil, sand and pebbles) in your bin.
2. Form a mountain at one end of the bin.
3. Draw a picture of the bin with the mountain before blowing.
4. Gently blow on the mountain with your straw. Record your findings.
5. Blow with slightly more force on the mountain. Record your findings. Be careful not to blow soil into anyone's face or out of the bin.
6. Blow with more force than the last time. Record your findings.

Results

1. Draw and label a picture of the bin with the mound before any blowing takes place.

   Students should draw and label a picture.

2. Draw and label a picture after the bin and mountain after slight wind has blown.

   Students should draw and label a picture.

3. Which material is scattered the most? Why does this happen?

   The topsoil and sand should move the most. This is because they are lightest.

4. Which material is scattered the least? Why does this happen?

   The bigger pebbles scattered the least. This is because they are heavier and harder to move.

5. Draw and label a picture of what happens when more wind is blown on the mountain.

   Students should draw and label a picture.

6. Draw and label a picture of what happens at the end of the experiment. Draw arrows on the picture to show what happens what happens as wind hits the mountain.

   Students should draw and label a picture. Arrows should be included.

Conclusions

1. What happened as more wind force was added to blow on the mountain?

   As more wind force is added, more sand and topsoil should be moved as well as some pebbles. The mountain should get shorter/smaller.

2. What type of material was displaced the easiest?

   Topsoil and sand should be displaced the easiest.

3. What type of material took the most force to move?

   Gravel and pebbles should take the most force to move.

4. What precautions would farmers have to take to protect their soil from wind erosion?

   They should have cover crops. Crops should not be planted at the top of hills. No-till farming would also help protect soil.

5. Where in Michigan can you see wind erosion?

   In Michigan, fields were crops grow and beaches along the Great Lakes.

6. How does wind affect sand dunes?

   Wind affects sand dunes by moving and eroding them.

7. How do your results compare with your hypothesis?

Students should compare their hypothesis to the activity results.

Name:________________
Hour:____ Date:________

Sediment Deposition Activity

Purpose: To determine how sediments are deposited in a variety of environments.

Pre-Activity Questions:

1. What are the different types of sediments?

2. How are sediments formed?

3. How is most sediment moved? Are there other ways sediments are moved?

4. Where can sediments be deposited?

Procedure:
Shake the sediment tube gently so the sediments are suspended in the water. Put the tube on its side. Observe the tube for several minutes. Repeat the above steps and then answer the following questions.

1. Write 3 observations about what happened in the sediment tube.

2. What causes sediments to either sink or float?

3. Draw a picture of the sediment tube. Using your types of sediment chart and a ruler, determine the type of sediment and label it on your diagram.

4. What causes the order the sediments are deposited?

Next, you will be determining how moving water and sediments interact with one another.

Take the sediment tube and tilt it up and down slightly. You will want to do this slowly so you can observe what is happening to the sediments as you move the tube.

5. Write 3 observations about sediments and moving water.

6. What happens to the gravel in the tube?

7. What type of weathering will happen to the gravel as it travels down a river bed? What would happen to the shape of the gravel?

8. What happens to the sand in the tube?

9. What happens to the silt and clay in the tube?

10. What happens to the plant material in the tube?

11. How do materials travel differently along the bottom of the tube?

Name:________________
Hour:_____ Date:_______

Types of Sediments

Sediment	Size	Description
Boulder		
Gravel		
Sand		
Silt		
Clay		
Plant Remains		
Animal Remains		
Salts		

Name: Key
Hour:____ Date:________

Sediment Deposition Activity

Purpose: To determine how sediments are deposited in a variety of environments.

Pre-Activity Questions:

1. What are the different types of sediments?

The different types of sediments are boulders, gravel, sand, silt, clay, plant & animal remains and salts.

2. How are sediments formed?

Sediments are formed by mechanical or chemical weathering.

3. How is most sediment moved? Are there other ways sediments are moved?

Most sediment is moved by water. Other ways sediments are move include wind, glaciers and gravity.

4. Where can sediments be deposited?

Sediments can be deposited in lakes, flood plains, rivers, deserts, deltas, oceans and swamps.

Procedure:
Shake the sediment tube gently so the sediments are suspended in the water. Put the tube on its side. Observe the tube for several minutes. Repeat the above steps and then answer the following questions.

1. Write 3 observations about what happened in the sediment tube.

   Student responses will vary. Should include observations of how sediments settle out.

2. What causes sediments to either sink or float?

   The density of the sediment determines if it will sink or float. If it sinks, the density is greater than 1 g/ml.

3. Draw a picture of the sediment tube. Using your types of sediment chart and a ruler, determine the type of sediment and label it on your diagram.

   Students should draw a diagram and label it. Gravel should be on the bottom, sand on top of the gravel, silt and clay on top of the gravel as well as suspended and plant and animal remains on the top and floating.

4. What causes the order the sediments are deposited?

The size and density of sediments determines the order they are deposited.

Next, you will be determining how moving water and sediments interact with one another.

Take the sediment tube and tilt it up and down slightly. You will want to do this slowly so you can observe what is happening to the sediments as you move the tube.

5. Write 3 observations about sediments and moving water.

Student observations will vary. Should include sand moving along the bottom.

6. What happens to the gravel in the tube?

The gravel was on top of the sand.

7. What type of weathering will happen to the gravel as it travels down a river bed? What would happen to the shape of the gravel?

The gravel is undergoing mechanical weathering (abrasion). The gravel should get smaller and smoother as weathering continues.

8. What happens to the sand in the tube?

The sand goes to the bottom of the tube underneath all the other sediments.

9. What happens to the silt and clay in the tube?

The silt and clay settle out on top but some still remains suspended as the water moves.

10. What happens to the plant material in the tube?

The plant material settles out and sinks beneath the gravel and sand.

11. How do materials travel differently along the bottom of the tube?

The materials are no longer sorted by density with sand on the bottom of the tube. The sediment also rubs against each more causing more mechanical weathering.

Name:________________

Hour:_____ Date:______

Types of Sediments

Sediment	Size	Description
Boulder	*From 6 inches to many feet in diameter*	*Formed from mechanical weathering*
Gravel	*From 1/8 to 6 inches in diameter*	*Formed from mechanical weathering*
Sand	*From barely visible to 1/8 of an inch in diameter*	*Formed from mechanical weathering; will loosely stick together when wet*
Silt	*Individual pieces are not visible*	*Formed from chemical weathering; stick together & form mud; make water cloudy*
Clay	*Individual pieces are not visible; 10X smaller than silt particles*	*Formed from chemical weathering; stick together & form mud; when dry form powder; feels creamy*
Plant Remains	*Pieces have many sizes*	*May be plant roots, stems, leaves, flowers, fruits; will float in moving water; thick layers form muck*
Animal Remains	*Pieces may be seen or dissolved in water*	*May be seashells, tiny skeletons, bones or teeth*
Salts	*Particles cannot be seen*	*Formed from evaporation of ocean water*

Name:____________________
Hour:____________________

Stream Table Activity

Draw a picture of the stream table before any water has been started.

High End   Low End

Once the water is started you will need to take a meter stick and lay it along the stream. Next, take a piece of Styrofoam and record how long it takes to go one meter to find the stream speed.

Trial	Seconds to go 1 meter	Stream Velocity (cm/sec)
1		
2		
3		
Average		

Fill in the chart and draw a picture below after the stream has been running for approximately 5 minutes.

High End   Low End

Location	Width(cm)	Depth(cm)	Form Ratio (depth/width)
Head			
Center			
Mouth			
Stream Average			

Write a description of what has happened to the stream.

Let the stream run for 10 to 15 minutes more. Draw a picture of the stream in the space below.

High End Low End

Find the velocity of the stream. Fill in the charts below.

Trial	Seconds to go 1 meter	Stream Velocity (cm/sec)
1		
2		
3		
Average		

Location	Width(cm)	Depth(cm)	Form Ratio (depth/width)
Head			
Center			
Mouth			
Stream Average			

Conclusions:

1. How did the river change from start to finish?

2. How does erosion in a stream occur?

3. Where are the sediments deposited?

4. How did the velocity change?

5. How did the form ratio change from start to finish?

6. How could you determine if a stream is young or old?

7. What would help a riverbank stay stable?

8. How did flow of the stream change?

Name: Key
Hour:____________________

Stream Table Activity

Draw a picture of the stream table before any water has been started.

High End Low End

Once the water is started you will need to take a meter stick and lay it along the stream. Next, take a piece of Styrofoam and record how long it takes to go one meter to find the stream speed.

Trial	Seconds to go 1 meter	Stream Velocity (cm/sec)
1		*Students divide the seconds by 100 cm to find velocity*
2		
3		
Average		

Fill in the chart and draw a picture below after the stream has been running for approximately 5 minutes.

High End Low End

Location	Width(cm)	Depth(cm)	Form Ratio (depth/width)
Head			
Center			
Mouth			
Stream Average			

Write a description of what has happened to the stream.

Student responses will vary. Should include if stream is getting wider and if path of stream is changing.

Let the stream run for 10 to 15 minutes more. Draw a picture of the stream in the space below.

High End Low End

Find the velocity of the stream. Fill in the charts below.

Trial	Seconds to go 1 meter	Stream Velocity (cm/sec)
1		*Student should divide time by 100 cm to find velocity.*
2		
3		
Average		

Location	Width(cm)	Depth(cm)	Form Ratio (depth/width)
Head			
Center			
Mouth			
Stream Average			

Conclusions:

1. How did the river change from start to finish?

Students should note the river got wider from start to finish.

2. How does erosion in a stream occur?

Erosion occurs at the banks of the stream making it wider as well as the bottom.

3. Where are the sediments deposited?

Sediments are deposited at the mouth of the stream.

4. How did the velocity change?

The velocity should get slower as more sediments are carried.

5. How did the form ratio change from start to finish?

The ratio should get smaller, the stream gets wider and deeper, except for the mouth which should increase since it gets wider and shallower.

6. How could you determine if a stream is young or old?

This could be determined by looking at the depth and width of the stream. If it is wider and deeper than it is older. The mouth of a younger river would be narrower and deeper.

7. What would help a riverbank stay stable?

By having more plants and large rocks along the river bank. No flooding.

8. How did flow of the stream change?

The flow should increase as the stream becomes wider and deeper.

Name:_______________
Hour:________________

Rates of Sedimentation Lab

Purpose: In this activity, students will determine what type of sediment has the fastest settling rate.

Manipulated Variable:

Responding Variable:

Control Variables:

Hypothesis:

Procedure:

1. Fill the graduated cylinder with approximately 1000 mL of water.
2. Measure the length of the water in the graduated cylinder.
3. Take 5 limestone pieces and measure the time it takes each one to go the distance from the top of the water to the bottom.
4. Repeat step 3 for pebbles, sand, and topsoil.
5. Find the rate of settling for each type of sediment.
6. Find an average for each rate of settling.

Limestone pieces

Trial	Length (cm)	Time (sec)	Velocity (cm/sec)
1			
2			
3			
4			
5			
Average			

Pebbles

Trial	Length (cm)	Time (sec)	Velocity (cm/sec)
1			
2			
3			
4			
5			
Average			

Sand

Trial	Length (cm)	Time (sec)	Velocity (cm/sec)
1			
2			
3			
4			
5			
Average			

Topsoil

Trial	Length (cm)	Time (sec)	Velocity (cm/sec)
1			
2			
3			
4			
5			
Average			

Conclusions

1. Which sediment had the fastest rate of settling? Why?

2. Which sediment had the slowest rate of settling? Why?

3. How would these rates of settling affect the formation of sedimentary rock?

4. How was settling different between the sediments? How did this affect the time the sediments took to settle?

5. What are some possible sources of error for this lab?

6. How could you improve you results for this lab?

7. How did your results compare with your hypothesis?

Name: Key

Hour:

Rates of Sedimentation Lab

Purpose: In this activity, students will determine what type of sediment has the fastest settling rate.

Manipulated Variable: *Type of sediment*

Responding Variable: *time/velocity*

Control Variables: *water, meter stick, stop watch, graduated cylinder*

Hypothesis: *Example: If the sediment is larger/heavier, then it will settle faster.*

Procedure:

1. Fill the graduated cylinder with approximately 1000 mL of water.
2. Measure the length of the water in the graduated cylinder.
3. Take 5 limestone pieces and measure the time it takes each one to go the distance from the top of the water to the bottom.
4. Repeat step 3 for pebbles, sand, and topsoil.
5. Find the rate of settling for each type of sediment.
6. Find an average for each rate of settling.

Limestone pieces

Trial	Length (cm)	Time (sec)	Velocity (cm/sec)
1			
2			
3			
4			
5			
Average			

Pebbles

Trial	Length (cm)	Time (sec)	Velocity (cm/sec)
1			
2			
3			
4			
5			
Average			

Sand

Trial	Length (cm)	Time (sec)	Velocity (cm/sec)
1			
2			
3			
4			
5			
Average			

Topsoil

Trial	Length (cm)	Time (sec)	Velocity (cm/sec)
1			
2			
3			
4			
5			
Average			

Conclusions

1. Which sediment had the fastest rate of settling? Why?
   The limestone or pebbles should have the fastest rate of settling.

2. Which sediment had the slowest rate of settling? Why?
   The topsoil or the sand should have the slowest rate of settling.

3. How would these rates of settling affect the formation of sedimentary rock?

   The rates of settling will affect the formation of sedimentary rock by the type of rock formed. If sand settles faster than silt than sandstone will be formed.

4. How was settling different between the sediments? How did this affect the time the sediments took to settle?

   The bigger sediments settled faster and smaller sediment settled slower.

5. What are some possible sources of error for this lab?

   Some possible sources of error include timing errors, using different amounts of topsoil and sand, and length measurement errors.

6. How could you improve you results for this lab?

   To improve results for this lab, more trials could be done, a long tube could be used, and having more careful measurements.

7. How did your results compare with your hypothesis?

   Students should compare their hypothesis with results from the activity.

Name:_______________
Hour:________________

Weathering & Erosion at School

Parking Lot

Mechanical Weathering

Chemical Weathering

Erosion

Bus Circle

Mechanical Weathering

Chemical Weathering

Erosion

Front Door

Mechanical Weathering

Chemical Weathering

Erosion

Name: Key

Hour:

Weathering & Erosion at School

Parking Lot

Mechanical Weathering

- *Animals - ant hills*
- *Plant roots breaking cracks in asphalt*
- *Water in cracks expanding as ice*
- *Cars driving causing abrasion*

Chemical Weathering

- *Rust in asphalt*
- *Rust on pipe on side of school*

Erosion

- *Wind blowing sand/dirt on places with no grass*
- *Water moving sand/dirt on places with no grass*

Bus Circle

Mechanical Weathering

- *Animals - ant hills*
- *Plant roots breaking cracks in asphalt*
- *Water in cracks expanding as ice*
- *Cars driving causing abrasion*

Chemical Weathering

- *Rust in asphalt*
- *Acid rain possibly wearing trees and rocks*

Erosion

- *Wind blowing sand/dirt on places with no grass*
- *Water moving sand/dirt on places with no grass*

Front Door

Mechanical Weathering

- *Lichens on wall*
- *Plant/tree roots in cracks*
- *Ant hills in cracks.*
- *Ice breaking the cement in cracks.*
- *Bricks breaking because of ice*

Chemical Weathering

- *Rust in rocks on sidewalk*
- *Acid precipitation on bricks and limestone 1958 sign*

Erosion

- *any area without grass/plant coverage has erosion by water and wind*

Name:________________
Hour:_________________

Science Poetry

Your job is to write a science poem about the rock cycle, acid precipitation or weathering and erosion. You will need to show you learned something about the topic your poem is about. The poem should have at least one poetic device such as a simile, metaphor or hyperbole. The poem may be a free verse, rhyming or concrete (shape). Your poem must be neatly written and include an illustration that relates to your poem in some way. We will go through several examples of poems in class.

The grade for this poem will be for both science and language arts. The following rubric will be used to grade your poem. This sheet with the rubric should be turned in with your poem on Monday, June 5.

Science Poem Rubric

Title - 5 points	_______
Poem shows understanding of science topic - 25 points	_______
Poetic Device Included - 5 points	_______
Illustration in color, neat, topic - 10 points	_______
Poem in final copy and neat presentation - 5 points	_______
Total out of 50 points	_______

APPENDIX D

In Science I Learn

In science i learned that even
the highest mountain can become
the smallest over hundrens of years
and that water can
overcome anything and wash away nutrients in the soil
destorying farmland
and i learned how to protect farmland
and how to keep soil inplace
and what farming method to use
to restore nutrients in the soil
and how the rock cycle works
and how sediment is made
and that rivers, gravity, and wind
can carry stuff from here to there
and make new landforms

On the Rock Cycle you will Ride

Nobody stops the cycle of a rock.
Nobody stops a river with a block
Nor winds armed each with some sand
and each type of a rock,
each the opposite of a sock.

Then slung me worst with the weathering.
Then creep me deep with the erosion thing.
Let idle winds erode the rocks.
You shall be cemented like the blocks.

On the rock cycle you shall ride.
They shall tell you of heat and pressure.
On the rock cycle you shall ride.

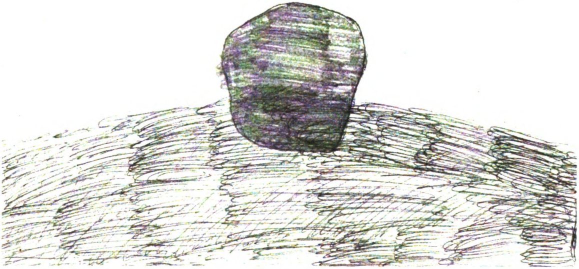
(The water erodes the ground)

I Am Eroding

I am a rock
Sitting on the ledge of a stream
Here it comes
Here comes the water
Over and over

Oh no some of me is gone
There I go
Some of me is washed down
Into the stream I go

Over and over the water hits me like a train
And washes me away
Over and over
Again and again



RAIN AND SNOW

ACID PRECIPITATION.

The stakes shoot the smoke into the atmosphere
A million tons of smoke each day.
The cars make the sky blacken, dark and dirty.
The sky is as dark as a dirty, mangy cat.

ACID PRECIPITATION.

Which comes back down as acid precipitation.
It destroys the trees and the monuments and signs, on the
Building walls. So the companies tried
to make it better by adding scrubbers but still
more was needed. We still need to stop sulfur
dioxide emissions.

ACID PRECIPITATION.

The trees burn and you can see burn marks on the leaves.
Its not just rain, its snow and hail and all kinds of
precipitation. Any thing that falls from the sky and
has a high acid percent. Acid precipitation!!!!

ACID PRECIPITATION.

Erosion

The rain is coming,
We will see some debris,
The more rain that comes,
The more destruction we see.

Rain slides down the hill,
Mud and dirt come too,
The crops start to flood,
We will have lots of work to do.

Planting grass to keep the dirt in place,
To save the ground from erosion,
Placing rocks for landscaping,
May stop some of the corrosion.

Science Class

I always thought weathering and erosion was best,
There are so many types to go along this topic
Such as rain
And ice
And plants
And ant hills
And acid rain
And even the buses in a bus lane can erode rock
And in a parking lot
And by a front door
And that erosion can make spectacular beauties
Such as the Bryce Canyon
And Grand Canyon
There for that is why I like weathering and erosion best.

In Science Class

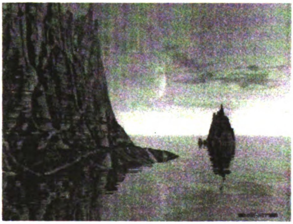
In science class I've learned . . .
How weathering breaks down rocks
And how sediments are compacted together like cement blocks.
How sediments are eroded
And that some sand particles even floated.

In science class I've learned . . .
How to use force to weather
And how sediments are put under pressure to be compacted together.
How to circle round and round
In the never-ending rock cycle under ground.

In science class I've learned . . .
How to experiment with new things
And how to experience what acid precipitation brings.
How to help the air pollution
And how to come up with thorough conclusions.

In science class I've learned . . .
New stuff that has helped me grow
New things that expand what stuff I already know.

Thanks for a wonderful year Mrs. Mcgaugh



The Rock Cycle

There once was some lava
Who was crying about,
But cooled into a igneous rock
Without a doubt.

There once was a igneous rock
Who was wailing about,
But turned into sediment
Into a lake with some trout.

There once was some sediment
Happy and free,
Who was cemented to a sedimentary rock
Like in a cage with out a key.

There once was a sedimentary rock
Trying to suffice,
But heated into a metamorphic rock
Which was not very gneiss.

There once was a metamorphic rock
At a restaurant called Bennigans,
Who was heated and melted
To lava again!

Weathering

Big Rocks,
Small Rocks,
Tumbling, Fumbling
Through.
CRASH! SMASH! BASH! LASH!
Pieces scattered,
Who was who?
Water swish-swash
Side to side,
No one really wondered why.
CRACK! HACK! NACK! WACK!
Now those pieces are through.

The Ten Days Of The Rock Cycle

To the tune of the 12 days of Christmas

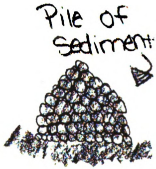
On the first day of the rock cycle Dr. Boulder gave me
A really big igneous rock

On the second day of the rock cycle Dr. Boulder gave me
2 weathered and eroded rocks
And a really big igneous rock

On the third day of the rock cycle Dr. Boulder gave me
3 piles of sediments
2 weathered and eroded rocks
And a really big igneous rock

On the fourth day of the rock cycle Dr. Boulder gave me
4 compacted and cemented rocks
3 piles of sediment
2 weathered and eroded rocks
And a really big igneous rock

On the fifth day of the rock cycle Dr. Boulder gave me
5 sedimentary rocks
4 compacted and cemented rocks
3 piles of sediment
2 weathered and eroded rocks
And a really big igneous rock



On the sixth day of the rock cycle Dr. Boulder gave me
6 rocks undergoing heat and pressure
5 sedimentary rocks

4 compacted and cemented rocks
3 piles of sediment
2 weathered and eroded rocks
And a really big igneous rock

On the seventh day of the rock cycle Dr. Boulder gave me
7 metamorphic rocks
6 rocks undergoing heat and pressure
5 sedimentary rocks
4 compacted and cemented rocks
3 piles of sediment
2 weathered and eroded rocks
And a really big igneous rock

On the eighth day of the rock cycle Dr. Boulder gave me
8 melting rocks
7 metamorphic rocks
6 rocks undergoing heat and pressure
5 sedimentary rocks
4 compacted and cemented rocks
3 piles of sediment
2 weathered and eroded rocks
And a really big igneous rock

On the nineth day of the rock cycle Dr. Boulder gave me
9 piles of magma
8 melting rocks
7 metamorphic rocks
6 rocks undergoing heat and pressure
5 sedimentary rocks
4 compacted and cemented rocks
3 piles of sediment
2 weathered and eroded rocks

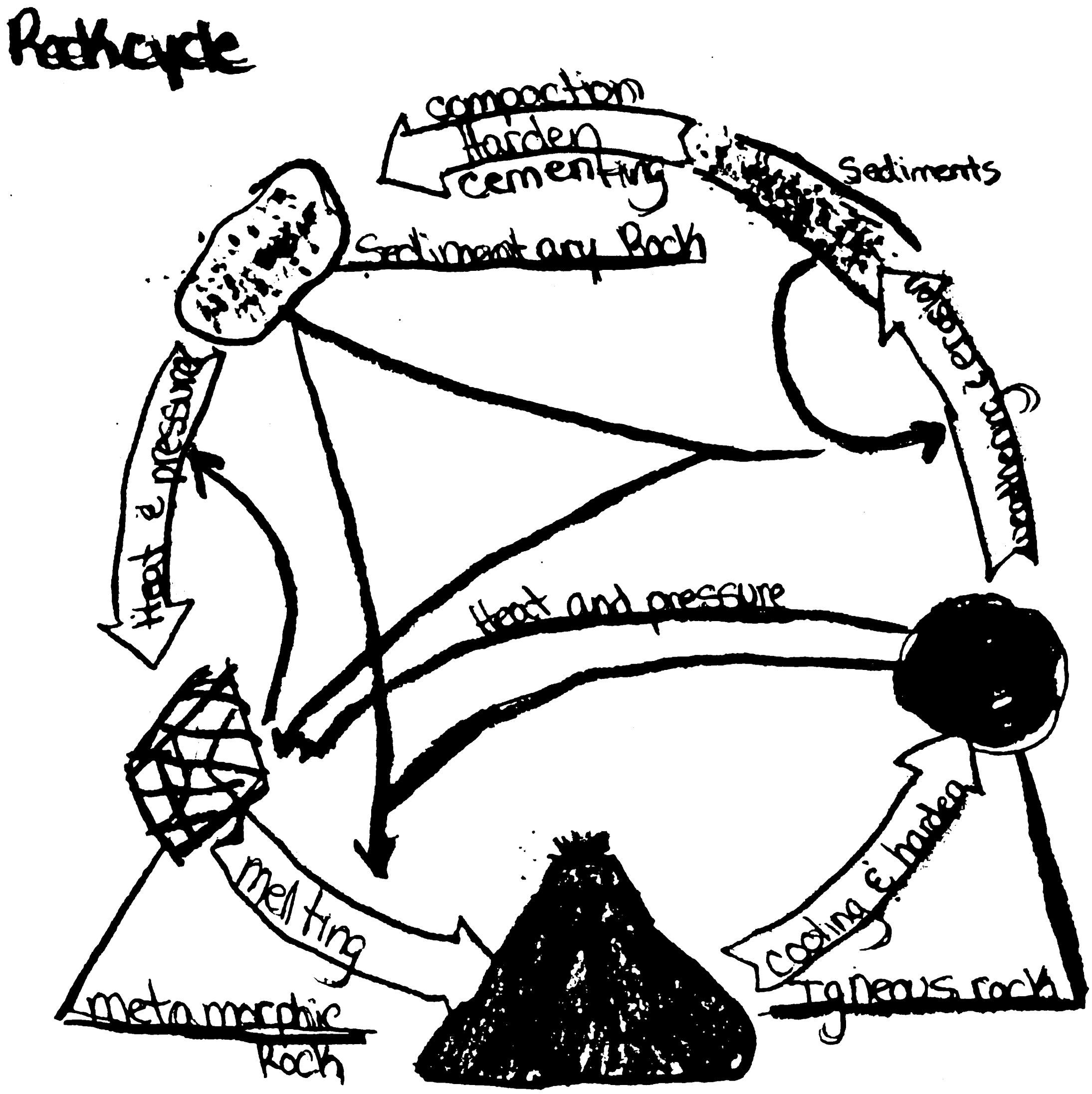
And a really big igneous rock

On the tenth day of the rock cycle Dr. Boulder gave me
10 diagrams of the rock cycle
9 piles of magma
8 melting rocks
7 metamorphic rocks
6 rocks undergoing heat and pressure
5 sedimentary rocks
4 compacted and cemented rocks
3 piles of sediment
2 weathered and eroded rocks
And a really big igneous rock

Student's Work

In science I've learned…
How to learn the rock cycle
How magma can turn into igneous rock
How sedimentary rock can turn into heat and pressure
How weathering and errions can turn into sediments

In science I've learned…
How a river can be eroded
How errion washes soil away
How weathering breaks down rocks into rock cycle
How weathering can contract and expand

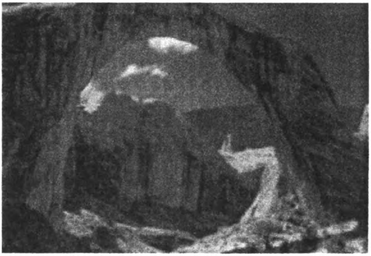


Weathering

Weathering is very orderly, and extra extraordinary
Weathering is crazy, but not on a daisy
The rock will freeze, but not with a breeze
The rock can crack, not in a shack
With every sediment, you don't get a breath mint
The rock can weather, but not in good weather
It just sits there, for thousands of years.

Weathering and Erosion

Weathering and Erosion
has always been
a interest to me
you can see rocks
on the surface
and see what cycles it has been through
and how it has been broken down
and see that it has been moved
and how it had gotten there
and what types of rocks are on the surface
and how grass can go through the cement cracks.



Student's Work

In Science I Learn

In science i learned that even
the highest mountain can become
the smallest over hundrens of years
and that water can
overcome anything and wash away nutrients in the soil
destorying farmland
and i learned how to protect farmland
and how to keep soil inplace
and what farming method to use
to restore nutrients in the soil
and how the rock cycle works
and how sediment is made
and that rivers, gravity, and wind
can carry stuff from here to there
and make new landforms

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