Reading the River, Summer 2006

Reshaping the Crust—A Unit for Grades 9-12 Special Topics in Science

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Modeling the formation of a River System with and without pollutants present

Grade Levels: 9-12

Objectives:

At the end of this lesson, students will be able to:

- Describe the formation of a river system.
- Evaluate the affects of pollutants on water sources.
- Compare the formation of a river system in the presence and absence of pollutants
- Discuss the effects of small amounts of water pollution on various ecosystems

Program of Studies:

Big Idea: Motion and Forces (Physical Science)

Whether observing airplanes, baseballs, planets, or people, the motion of all bodies is governed by the same basic rules. At the middle level, qualitative descriptions of the relationship between forces and motion will provide the foundation for quantitative applications of Newton's Laws. These ideas are more fully developed at the high school level along with the use of models to support evidence of motion in abstract or invisible phenomena such as electromagnetism.

High School Enduring Knowledge – Understandings

Students will understand that

the usefulness of a model can be tested by comparing its predictions to actual observations in the real world. But a close match does not necessarily mean that the model is the only "true" model or the only one that would work.

High School Skills and Concepts

Students will

create and analyze graphs, ensuring that they do not misrepresent results by using inappropriate scales or by failing to specify the axes clearly

Big Idea: The Earth and the Universe (Earth/Space Science)

The Earth system is in a constant state of change. These changes affect life on Earth in many ways. At the high school level, most of the emphasis is on why these changes occur. An understanding of systems and their interacting components will enable students to evaluate supporting theories of Earth changes. The use of models and observance of patterns to explain common phenomena is essential to building a conceptual foundation and supporting ideas with evidence at all levels. Patterns play an important role as students seek to develop a conceptual understanding of gravity in their world and in the universe. High school is the time to bring all of the ideas together to look at the universe as a whole. Students will use evidence to evaluate and analyze theories related to the origin of the universe and all components of the universe.

High School Enduring Knowledge – Understandings

Students will understand that

the shape and location of the continents have been gradually changing for millions of years because density differences inside the mantle result in convection currents. These changes, as well as more rapid ones (e.g. earthquakes, volcanoes, tsunamis) can impact living organisms.

• mathematical models and computer simulations are used in studying evidence from many sources to form a scientific account of the universe.

• scientists rely on increasingly sophisticated methods of measurement in order to investigate a variety of phenomena that were previously immeasurable.

• curiosity, honesty, openness and skepticism are highly regarded in science, and are incorporated into the way science is carried out.

High School Skills and Concepts

Students will

explain the role of gravity in the formation and function of the universe

• investigate, describe and document patterns of interaction of matter and gravity

explore real-life implications of current findings in Earth/space research and communicate findings in an authentic form, exemplifying the traits of curiosity, honesty, openness and skepticism

Big Idea: Biological Change (Biological Science)

The only thing certain is that everything changes. At the high school level, students evaluate the role natural selection plays in the diversity of species. Modern ideas of evolution provide a scientific explanation for three main sets of observable facts about life on Earth: the enormous number of different life forms we see about us, the systematic similarities in anatomy and molecular chemistry we see within that diversity, and the sequence of changes in fossils found in successive layers of rock that have been formed over more than a billion years.

High School Enduring Knowledge – Understandings

Students will understand that

• the survival of any given species is not assured. There are a variety of factors (e.g. reproductive success, mutation, availability of resources, competition) that may determine if a species flourishes, declines, or eventually becomes extinct.

some organisms have greater adaptive capabilities than others, giving them a greater chance of survival under changing environmental conditions. These adaptations may be patterns of behavior as well as physical characteristics.

• the endangerment/ and/or extinction of a species cannot be slowed or prevented without sufficient data to model the interactions of the factors involved.

High School Skills and Concepts

Students will

explain the role of natural selection in speciation, adaptation, diversity and phylogeny

• compare variations, tolerances and adaptations (behavioral and physiological) of plants and animals in different biomes

• generate possible solutions to real-world problems of endangered and extinct species and predict the impact of a variety of change

• predict the likelihood of survival for a variety of existing species based upon predicted changes in environmental conditions (e.g., global warming, continental drift) and propose methods to prevent the extinction of species with insufficient ability to adapt

Core Content:

Big Idea: THE EARTH AND THE UNIVERSE

The Earth system is in a constant state of change. These changes affect life on earth in many ways. Development of conceptual understandings about processes that shape the Earth begin at the elementary level with understanding *what* Earth materials are and that change occurs. At the middle level, students investigate *how* these changes occur. Finally, at the high school level, most of the emphasis is on *why* these changes occur. An understanding of systems and their interacting components will enable students to evaluate supporting theories of earth changes. At the heart of elementary students' initial understanding of the Earth's place in the universe is direct observation of the earth-sun-moon system. Students can derive important conceptual understandings about the system as they describe interactions resulting in shadows, moon phases, and day and night. The use of models and observance of patterns to explain common phenomena is essential to building a conceptual foundation and supporting ideas with evidence at all levels. In middle school, students begin to look beyond what can be directly observed as they explore the earth-sun-moon system, as well as the rest of our solar system, employing the concept of scale within their models. Patterns play an important role as students seek to develop a conceptual understanding of gravity in their world and in the universe. High school is the time to bring all of the ideas together to look at the universe as a whole. Students will use evidence to evaluate and analyze theories related to the origin of the universe and all components of the universe.

SC-HS-2.3.10 Students will predict consequences of both rapid (volcanoes, earthquakes) and slow (mountain building, plate movement) earth processes from evidence/data and justify reasoning.

The Earth's surface is dynamic; earthquakes and volcanic eruptions can be observed on a human time scale, but many processes, such as mountain building and plate movements, take place over hundreds of millions of years. DOK 3

Big Idea: STRUCTURE AND TRANSFORMATION OF MATTER

A basic understanding of matter is essential to the conceptual development of other big ideas in science. In the elementary years of conceptual development, students will be studying properties of matter and physical changes of matter at the macro level through direct observations, forming the foundation for subsequent learning. During the middle years, physical and chemical changes in matter are observed, and students begin to relate these changes to the smaller constituents of matter—namely, atoms and molecules. By high school, students will be dealing with evidence from both direct and indirect observations (microscopic level and smaller) to consider theories related to change and conservation of matter. The use of models (and an understanding of their scales and limitations) is an effective means of learning about the structure of matter. Looking for patterns in properties is also critical to comparing and explaining differences in matter.

SC-HS-1.1.6 Students will

- **identify variables that affect reaction rates;**
- **predict effects of changes in variables (concentration, temperature, properties of reactants, surface area, and catalysts) based on evidence/data from chemical reactions.**

Rates of chemical reactions vary. Reaction rates depend on concentration, temperature, and properties of reactants. Catalysts speed up chemical reactions. DOK 3

Big Idea: BIOLOGICAL CHANGE

The only thing certain is that everything changes. Elementary students build a foundational knowledge of change by observing slow and fast changes caused by nature in their own environment, noting changes that humans and other organisms cause in their environment, and observing fossils found in or near their environment. At the middle school level, students study relationships among populations and ecosystems that contribute to the success or demise of a specific population or species. Students construct basic explanations that can account for the great diversity among organisms. The stage is set for high school students to evaluate the role natural selection plays in the diversity of species. Modern ideas of evolution provide a scientific explanation for three main sets of observable facts about life on earth: the enormous number of different life forms we see about us, the systematic similarities in anatomy and molecular chemistry we see within that diversity, and the sequence of changes in fossils found in successive layers of rock that have been formed over more than a billion years (*Science for All Americans, p. 67)*.

SC-HS-3.5.1 Students will

- ***predict the impact on species of changes to 1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, or (4) natural selection;***
- ***propose solutions to real-world problems of endangered and extinct species.***

Species change over time. Biological change over time is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) natural selection. The consequences of change over time provide a scientific explanation for the fossil record of ancient life forms and for the striking molecular similarities observed among the diverse species of living organisms. Changes in DNA (mutations) occur spontaneously at low rates. Some of these changes make no difference to the organism, whereas others can change cells and organisms. Only mutations in germ cells have the potential to create the variation that changes an organism's future offspring. DOK 3

SC-HS-3.5.2 Students will

- **predict the success of patterns of adaptive behaviors based on evidence/data;**
- **justify explanations of organism survival based on scientific understandings of behavior.**

The broad patterns of behavior exhibited by organisms have changed over time through natural selection to ensure reproductive success. Organisms often live in unpredictable environments, so their behavioral responses must be flexible enough to deal with uncertainty and change. Behaviors often have an adaptive logic. DOK 3

Materials:
Sand
Rubber Tubing
Stop Watches
Stream Tables
Hydrochloric acid
Soda Pop
Petroleum oil
Modern Earth Science Textbook
3-ring hole punch
Small circular pieces of paper
Scientific calculators
Rulers
Plastic containers to be used as sand traps
Disposable pipets
Computer lab

Activity Procedure:
In this lab activity, students will demonstrate how a headwater source begins a river system of rivers and tributaries.
Students will begin by obtaining their materials. The first step will be for students to calculate the flow rate of the water that they are putting into their stream tables. This will be done by timing the length of time it takes for the small circular pieces of paper created from the 3-ring hole punch to travel down the chute. Students will do this 3 times at various heights for the stream table. The ruler will be used to measure how high the stream table is placed at each time as well. After flow rates have been calculated, students will pack sand into the stream table. They will then allow the water to flow through the tubing and watch how the water forms tributaries and streams. Students will describe what they find and we will take some time to discuss their findings.

After performing the basic stream formation part of the activitiy, students will be assigned one of 3 pollutants (soda pop, petroleum oil, hydrochloric acid). They will need to add 4-5 drops of their pollutant to their streams. Afterwards, students should record any changes in the development of how the streams shape and how the sand seems to react with the pollutant.

Following this basic part of the activity, students will need to allow all of their water to drain into their sand traps. The sand will need to be repositioned and repacked into the stream table. We have 3 pollutants (soda pop, hydrochloric acid, and petroleum oil); which will be split up between the various groups of students. Students will use their disposable pipets to drop 4-5 drops of their assigned pollutant into the headwaters of their stream table. They will need to record any differences that they notice in how the streams form when compared to how they formed without pollutants present in the very beginning.

At the end of the activity, students will compile their data together so that they may all have the data for the preparation of their laboratory reports.

Students will follow this activity with a trip to the computer lab to research assigned ecosystems. Students will use their research to further analyze their data and discuss the affects that pollutants in our water has on not only the aquatic ecosystem, but also on human lives, forests, and land-dwelling creatures.

All students will research all areas that can be impacted by water pollution, but students will be split up into groups where they will be required to focus on particular aspects of our environment that is affected by water pollution. Student groups will lead the rest of the class in a discussion of how water pollution affects their assigned domain. Laboratory reports will not be due until after these discussions have been held.

Definition/Explanation of Concepts:

Rivers and streams are considered to be one of the most powerful forces on earth. They carve out masterful geologic structures such as the Grand Canyon. Water systems reshape Earth's crust constantly through flooding and through every day movement. However, aquatic ecosystems are fragile and easily upset by human activity and pollutants. Although there are organisms that help to filter pollutants out of our water sources, all too often we find that pollutants may begin at the head but do not become as diluted as one would think as they travel downstream. Pollution has many devastating affects on Earth when it contaminates our water sources.

Assessment:

1. Ability to follow directions in the laboratory setting.
2. Cooperation with peers to complete task.
3. Student led discussion
4. Participation in group discussions
5. Contribution to group research
6. Laboratory reports

Reference:

This lesson was adapted from a lesson created by the Appalachian Math and Science Partnership during their High School Earth Science workshop in the summer of 2005.

Lesson Context

The lesson above is sequenced in a science unit entitled "Reshaping the Crust" designed for high school students. The unit outline and lesson descriptions follow.

I.) Weathering and Erosion

1. Lesson 1: Weathering processes. KET Encyclomedia video.
2. Lesson 2: Rates of Weathering. How does the composition and type of rock affect the rate of weathering? What other factors affect the rate of weathering?
3. Lesson 3: Weathering and Soil. Conservation district speaker to discuss soil compositions and profiles along with other characteristics of soil.
4. Lesson 4: Weathering and Soil. Analyze soil samples to identify compositions, profiles, etc. Test soil samples for pH and other pollutants.
5. Lesson 5: Erosion. Develop plans to help prevent soil erosion. Some may use powerpoints, others posters, and others brochures or even newspaper articles to share with the local newspapers.

II.) Water and Erosion

1. Lesson 1: The Water Cycle. Students act out the stages of the water cycle.
2. Lesson 2: Water, Water Everywhere! Student discussion of the importance of water to life in various ways.
3. Lesson 3: River Systems. POwerpoint slide show of pictures of river systems and class discussion.
4. Lesson 4: Stream Deposition. Slide show illustrating affects of flooding and discussion of how flooding reshapes the crust and river banks. Discussion of how our high school football field was once part river and part riverbank.
5. Lesson 5: **Modeling the formation of a River System with and without pollutants present**

III.) Groundwater and Erosion

1. Lesson 1: Water Beneath the Surface. Discussion of groundwater and its importance in agriculuture and topography.
2. Lesson 2: Wells and Springs. Guest speaker from the water treatment plant to discuss how we dig for wells as well as the primary source of our city water.
3. Lesson 3: Groundwater and Chemical Weathering. Slide show of pictures of caverns, natural bridges, etc.
4. Lesson 4: Field Trip to Carter Caves.

Scoring Guide for Lab Reports					
Category	8	6	4	2	0
Background	Student describes the topic that the activity reinforces in great depth. The purpose of the activity is clearly articulated at the end of the background section before leading into the methods.	Student describes the topic that the activity reinforces. The purpose of the activity is stated at the end of the background section.	Student mentions the topic and key points of the topic that the activity reinforces. The purpose is stated, but is unclear.	Student gives the chapter that is being covered in class. There is no purpose statement or it is so confusing that one does not realize that it is the purpose.	There is no background section. Or There is only a purpose statement. Or The background provided is completely irrelevant.
	12	9	6	3	0
Methods	Methods are written in paragraph form and past-tense. They are clear and articulate the procedures to be followed by one who wants to repeat what you did and get the same results as you. There are diagrams that enhance the methods by illustrating what was done.	Methods are written in paragraph form and may or may not be in past-tense. They briefly explain the procedures to be followed, but they are not detailed enough for one to obtain the same results. There may or may not be some diagrams that assist in understanding the methods used during the activity.	Methods are in paragraph form, but not in the correct verb tense. They are not written well enough for someone else to repeat the activity. There are no diagrams. --or—Methods are listed in order completed (numbered or bullet points). The correct verb-tense may or may not be used. The steps are listed in such a way that one could repeat the activity.	Methods are listed in order completed. They are not in sentence form and are not in the correct verb tense. They are very brief and would be difficult for one to follow and obtain the same results.	There is not a methods section. Or The methods section is irrelevant to what was being done in the activity. or So confusing that no one understands what was done based on these methods.
	8	6	4	2	0
Results/ Observations *Observations will be included in this section of the lab report. Below is the scoring criterion for observations.	The results are provided in paragraph form along with tables and charts illustrating the results. The writer makes reference to the tables in the paragraph sections of the results. They are well written and brief and	The results are provided in paragraph form along with tables and charts illustrating the results. The writer may or may not refer to the tables and charts in the paragraphs. The wording is confusing as there are some	The results are listed in sentence form along with tables and charts. The writer does not make reference to the tables and charts in the sentences. There are some major grammar mistakes.	The results are explained in paragraph form. Or The results are briefly listed. There are no tables or charts. Or The results are only shown in the forms of tables and charts.	There is not a results section. Or Results are so incoherent that one cannot comprehend them. Or Results are irrelevant and illogical.

	concise.	minor grammar mistakes. They are not as concise.			
Observations	Observations are descriptive and detailed. The reader can easily envision what the writer is observing through the use of 2 of their 5 senses (sight and touch). There are minimal grammar and spelling mistakes.	Observations are descriptive, but not as detailed as those in the 4 point response. It is slightly more difficult for the reader to imagine him or herself in the writer's shoes although the writer does make brief mention of what they see and feel in completing the activity. There are a few grammar and spelling mistakes.	Observations are very brief and do not include any detail. Or The detail is incoherent and difficult to envision. The reader has great difficulty getting a mental image of what the writer experienced during the activity. There are several errors in grammar and spelling.	Observations are very simplistic. In some cases, they are one-worded and not written in complete sentences. There are several critical errors in grammar and spelling.	Assignment is not completed or is completely irrelevant or is incoherent.
	12	9	6	3	0
Discussion	The results are analyzed and conclusions are drawn from them. The discussion explains what information and insights were gained from the activity. It is well-articulated, clear, and concise.	The results are analyzed and conclusions are drawn from them. The discussion briefly mentions the information that was obtained from the activity. It is well written with few minor grammar errors.	The results were analyzed in terms of answering the questions that students were told should be addressed in the report (if any). Students may or may not have put these into paragraph form. There are no additional comments or insights offered. Students appear to have learned very little from the activity. There some grammar mistakes.	Students listed questions and answered them briefly. There are grammar mistakes. Students have gained very little from this activity.	There is no discussion section. Or The discussion seems irrelevant. The writer seems to have gained nothing from this activity. Or The discussion cannot be read for grammar mistakes.

Students will be graded for their participation based upon the following rubric:

Score	4	3	2	1	0
Participation	Student works very well with partner to accomplish goals established by teacher. Student does his share of the work and does not do all of the work or none of the work.	Student works well with partner to accomplish goals established by teacher. Students does some of the work, but it is not completely split up amongst partners (student does more or less of 50% of the work)	Student works with partner, but does not seem to split tasks up. Student either does the overwhelming majority of the work or does minimal work.	Student assists partner very little. Student either does all of the work or none of the work.	Student does not assist partner at all. There is no sharing amongst group members.
Time on Task	Students remain focused throughout the time period. They work diligently towards accomplishing the goals set by the teacher.	Students rarely get off task during the time period. They work hard towards accomplishing the goals set by the teacher.	Students get off task several times during the time period. They work towards accomplishing the goals set by the teacher, but they make little progress because of their use of time.	Students frequently get off task during the time period. The do minimal work towards accomplishing the goals set out by the teacher.	Students waste the time provided for them during class. They complete little to no work on the goals set by the teacher.

Students will receive points for participation in the class discussion based upon the following rubric:

Work with the Text	Student can identify the relationships between the given text and other texts with great insight.	Student can identify the relationships between the given text and other texts with good insight.	Student can identify the relationships between the given text and other texts with some insight.	Student can identify the relationships between the given text and other texts with limited insight.	Student cannot identify the relationships between the given text and other texts.
Synthesis of the Textual Content	Student synthesizes information to generate new, insightful, original ideas.	Student synthesizes information to generate new ideas	Student synthesizes information to generate predictable conclusions.	Student demonstrates limited synthesis of ideas. Conclusions drawn are the work of others.	Student does not demonstrate synthesis of ideas.

Use of Course Terminology	Student uses course terminology accurately and appropriately to enhance the discussion. Course terminlogy is used very frequently by the student.	Student uses course terminology accurately and appropriately. Course terminlogy is used frequently by the student.	Student uses course terminology accurately and appropriately, at times. Course terminlogy is sometimes used by the student.	Student is limited in the use of course terminology. Student seldomly uses course terminlogy appropriately.	Student demonstrates no use of course terminology.
Analytical and Evaluative Skills	Student uses multiple insightful and original examples to illustrate and support arguement. Analysis of subject matter demonstrates the recogniton of inferred ideas and the ability to connect the inferred ideas to other material. Student can add meaning to the concept/idea based upon contextual placement.	Student uses some examples to illustrate and support arguement. Analysis of subject matter demonstrates the recogniton of inferred ideas. Student demonstrates the ability to recognize contextual placement.	Student uses few examples that may not illustrate and support arguement. Analysis of subject matter demonstrates some recogniton of inferred ideas. Student demonstrates the some ability to recognize contextual placement.	Student uses one or two examples to illustrate and support arguement. Analysis of subject matter demonstrates limited recogniton of inferred ideas. Student demonstrates limited ability to recognize contextual placement.	Student does not use examples to illustrate and support arguement. Analysis of subject matter demonstrates no recogniton of inferred ideas. Student does not demonstrate the ability to recognize contextual placement.

Stream Table Data Sheets

Head= **Head=** **Head=**

Length= **Length=** **Length=**

Angle 1=		Angle 2=		Angle 3=	