Moving Plates

http://earth.rice.edu/activities/earthupdate/activities/EU13_movingplates.pdf

Focus on Inquiry

The student will measure the distance between two continents at two different time periods in Earth's history and calculate the average speed at which two continents are moving toward or away from each other.

Lesson Overview

Students use a map of Earth as it might have looked 94 million years ago and measure the average speed of separation of two continents over time in order to determine how fast the plates are moving.

Duration	Setting	Grouping	PTI Inquiry Subskills
70 minutes	Classroom	Pairs	3.8, 4.4, 5.2, 5.3, 5.6, 5.8, 7.3

Lesson Components	Estimated Time	Inquiry Subskills Used	Technology Used	Level of Student Engagement	Brief Description
Engage	10 min	4.4, 5.3, 5.8	Internet access/TV hookup	3	Students view plate tectonic animations and discuss plate tectonics. Students create a model of geologic time.
Explore	15 min	3.8, 4.4, 5.2	None	3	Students work in pairs to determine the rate at which the plates are moving.
Explain	15 min	5.3, 5.6, 7.3	None	3	Students share their findings and discuss discrepancies in the data.
Expand	15 min	4.4, 5.2, 5.3, 5.6	Internet	3	Students calculate the average speed of movement between the North American & South American plates. Discussion follows.
Evaluate	15 min	7.3	None	N/A	Answers on Blackline Master #1 can be used as assessment. An optional assessment is a writing prompt.

Level of Student Engagement

1	Low	Listen to lecture, observe the teacher, individual reading, teacher demonstration, teacher-centered instruction
2	Moderate	Raise questions, lecture with discussion, record data, make predictions, technology interaction with assistance
3	High	Hands-on activity or inquiry; critique others, draw conclusions, make connections, problem-solve, student-centered

National Science Education Standards – Inquiry

Develop descriptions, explanations, predictions, and models using evidence.
Think critically and logically to make the relationships between evidence and explanations.
Recognize and analyze alternative explanations and predictions.
Communicate scientific procedures and explanations.

National Science Education Standards – Earth Science

Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle.
The Earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past.

Louisiana Grade Level Expectations – Inquiry

Gr. 8, Inquiry GLE#9 – Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3)
Gr. 8, Inquiry GLE#12 – Use data and information gathered to develop an explanation of experimental results (SI-M-A4)
Gr. 8, Inquiry GLE#14 – Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5)
Gr. 8, Inquiry GLE#16 – Use evidence to make inferences and predict trends (SI-M-A5)
Gr. 8, Inquiry GLE#19 – Communicate ideas in a variety of ways (e.g., symbols, illustrations, graphs, charts, spreadsheets, concept maps, oral and written reports, equations) (SI-M-A7)

Louisiana Grade Level Expectations Earth Science

Gr. 8, GLE#11 - Illustrate the movements of lithospheric plates as stated in the plate tectonics theory (ESS-M-A2)
Gr. 8, GLE#35 - Describe how processes seen today are similar to those in the past (e.g., weathering, erosion, lithospheric plate movement) (ESS-M-B3)

Materials List

- Computer with Internet access
- Stopwatch or secondhand clock for the class
- Centimeter ruler for each student
- Calculator for each student

Advance Preparation

1. Obtain materials listed in the materials list.
2. Download and make student copies of Blackline Master #1 (available from **http://earth.rice.edu/activities/earthupdate/activities/EU13_movingplates.pdf)**.

Other Information

Learning Objective

The learner will:

- measure the distance between South America and Africa at two points in Earth's history.
- calculate the average speed at which South America and Africa have been moving apart.

Prior Knowledge Needed by the Students

- general knowledge of plate tectonics

Procedure

Engage

1. Have students view the plate tectonics animations available at http://www.ucmp.berkeley.edu/geology/anim1.html.
   Questions you might consider asking include:
   - What is Earth's estimated age? [~ 4.5 billion years old]
   - How many years of Earth history is represented by this video model?
2. Understanding the vastness of time is difficult. John McPhee, in his book Basin and Range, suggests using the following model to represent what this amount of time means: Stand with your arms held out to each side and let the extent of the earth's history be represented by the distance from the tips of your fingers on your left hand to the tips of the fingers on your right. If someone were to run a file across the fingernail of your right middle finger, then the time that humans have been on the earth would be erased!
   - How long does the online animation sequence of the moving plates last? [Time the sequence with a stopwatch - 9 seconds].
   - How many millions of years are represented by this video model? [Beginning age of video (XX million / 9 seconds = XX million/second of video]

Explore

1. Distribute **Blackline Master #1 (available from http://earth.rice.edu/activities/earthupdate/activities/EU13_movingplates.pdf)**, rulers, and calculators. Allow the students work in pairs and have them follow the directions on the second page of **Blackline Master #1**.

Explain

1. Discuss the students' responses. Look for any discrepancies in collected data, and have students give possible explanations for those discrepancies. [Human error, etc.]
   Questions you might consider asking include:
   - If you were an anteater that lived in the Congo (Africa) and your favorite cousin anteater lived a little bit to the west in the Amazon (South America), what would you have seen 156 million years ago? Would the anteater world have been rocked? When would your anteater family have to start sending Pterodactyl mail? Explain your reasoning.

Expand

1. Have the students follow the same activity procedures to calculate the average speed of movement between North and South America.
2. Discuss the students' responses. Questions you might consider asking include:
   - How does the speed of movement between North America and South America compare to that of South America and Africa? Is it faster, slower, or about the same?
   - What might account for the differences in speed?
   - Which pairs of continents appear to have moved the fastest? What evidence are you basing your response on?
   - How do you think plate movement is actually measured by scientists? What technology is available? [Three methods are used - GPS, seafloor magnetization and paleomagnetic poles]. *Note: An explanation of these three methods is found at http://geology.about.com/library/bl/blnutshell_platemoves.htm.*

Evaluate

1. Student answers to questions on Blackline Master #1.
2. Writing prompt: Based on the position and movement of the continents today, can you predict the future positions of Africa and Australia? What affect might future plate movement have on large bodies of water, such as the Atlantic Ocean? The Mediterranean Sea? Have students illustrate their predictions.

Blackline Master

1. Moving Plates (available at http://earth.rice.edu/activities/earthupdate/activities/EU13_movingplates.pdf)

Supplementary Resources

University of California (Berkeley) Museum of Paleontology, Geology – Plate Tectonics
http://www.ucmp.berkeley.edu/geology/tectonics.html
A review of the history behind and mechanisms that drive plate tectonics.

About.com: Geology: Five Myths of Plate Tectonics
http://geology.about.com/od/platetectonics/a/aa071104a.htm
The teacher may choose to discuss five common myths about plate tectonics. Have students discuss the possible origins of these myths.

Image of the World 50 million years from now
http://www.scotese.com/future.htm
(Note: This is a tie-in to Evaluation #2). The teacher may choose to show students one scientist's model of Earth fifty million years from now.

Cornell's Interactive Plate Tectonics Puzzle
http://atlas.geo.cornell.edu/education/student/continental_puzzle.html
Students may enjoy the interactive plate tectonics puzzle.