Title: Constructing and Visualizing Topographic Profiles

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Subject: Earth Science

Grade Level: 6 - 12

Standards:
NGSS: HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
--Cross-Cutting: Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale
NYSSS: 2.1q Topographic maps represent landforms through the use of contour lines that are isolines connecting points of equal elevation. Gradients and profiles can be determined from changes in elevation over a given distance.
NYSSS:
CCS: MHSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
CCS: MHSN.Q.A.3 Choose a level of accuracy appropriate to limitations of measurement when reporting quantities.

Schedule: 50 min.

CCMR Lending Library Connected Activities:

Objectives:	**Vocabulary:**
Given a Lego structure, students will create a profile and describe how the structure changes from left to right.	Topography Topographic Contour Elevation Hachure Profile Cross-section
Students Will: Students understand contour lines on maps represent lines of constant elevation. Students use a contour gauge to determine the contour of a Lego structure. Students explain the shape of the land as steep or flat. Students can verbally express the spatial angle of a profile in relation to topography.	**Materials:** Contour gauge per pair Lego blocks or 1 potato per pair Pencil Metric ruler per pair Scalpel or other cutting instrument for potato
Safety	Scalpels can puncture or cut skin. Always cut away from you. Contour gauges break easily, use only as intended.

Science Content for the Teacher:

A topographic map is a two-dimensional model depicting the three-dimensional shape of the land. Brown concentric circles called contour lines represent the third dimension. Contour lines are imaginary lines that connect areas of equal elevation above sea level. Each contour line is separated from the next by a uniform interval called the contour interval. Closely spaced contour lines indicate steep slope and widely spaced lines indicate shallow slope.

A variety of people use topographic maps including governments, geologist, and outdoor


enthusiasts. City officials use topographic maps to determine safe places to build houses and roads, as well as to study the distribution of plants and animals. A geologist might use a topographic map to assess the risk of natural hazards in the case of floods, landslides and earthquakes while the outdoor enthusiasts will use topographic map to plot out a hike across a particular terrain.

A geologist often will often construct a topographic profile "to visualize the shape of the land as if they had sliced through it. This helps them to see hazards, draw conclusions about the strike and dip of the geology beneath the land, among other applications."[1]

A profile is simply a cross-sectional view of the landscape between two points; it visually depicts the high and low points of the area.

Students have a hard time interpreting contour maps and difficulty translating this abstract idea into topographic profiles. There are two skills needed in successful understanding of topographic maps and profiles that often goes un-noticed: 1. Visual representations--students may lack the conceptual understanding that maps are models of Earth and a particular area will not have brown contour lines indicating elevation or steep slope. 2. Angle of spatial perspective--angle of spatial perspective means the angle at which maps are drawn. Maps are often drawn from an aerial view, looking down on Earth's surface. Whereas a profile is a cross-sectional view of earth, this is much harder for students to conceptualize. The task requires the student to take the flat, aerial view and convert it into a cross-sectional as viewed from the side.

This activity is designed to meet the challenges struggling students face when learning topographic maps. In particular, conversion between 2D and 3D, and visualizing objects in 3 dimensions. This lesson can be used after an introduction on topographic maps. Prior to beginning this activity students should have some familiarity with topographic maps.

Lego blocks have several advantages over potatoes and clay models when using the contour gauge: 1. Since he contour gauge responds to pressure, Legos provide a ridged surface for the teeth of the gauge to push against. 2. The shape of Lego blocks makes measurement reading a little more accurate and less cumbersome. 3. The contour gauge preserves the overall shape of the Lego blocks better than the potato and clay model from a student's point of view. And when transferring the outline onto paper, the duplicate image is sharper.

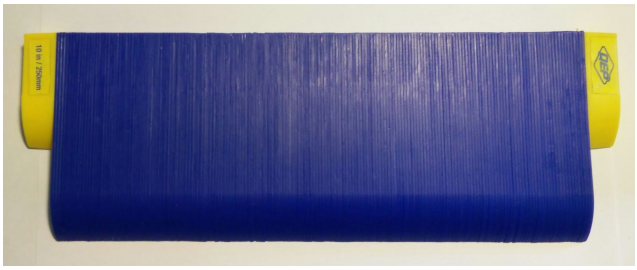

Classroom Procedure:

Advance preparation

Make small bags of Lego blocks with different sizes and shapes. Each group will need one bag with enough Lego blocks to build a structure that has a maximum length of 8 (2x2) blocks and a maximum height 4 (2x2) blocks. This allows the contour gauge to easily fit over the Lego structure. Suggested mixture of at least 20 2x2 or higher size blocks. In addition to the twenty blocks, include a combination of other shaped blocks to add variety to students' creation. Lego bases are very useful here. Construct a structure to use in the demonstration. If using the potato, pre-cut the potatoes, or go over and demonstrate safety procedures prior to students using scalpels.

Intro 10 min

Students read the definition of 'profile' on their activity sheet. (1 min) Teacher displays on the board an image of a Facebook profile and a topographic profile, asking students to compare their similarities, and describe how each image fits the definition of a profile. (3 min) Next, have students share their response with a neighbor. (3 min) Ask student volunteers to share their ideas. Accept all responses without judgment and write them on the board. (3 min) Be sure to explain pair-share protocol. First person speaks for 1 min while the other listens, then switch roles.



Demonstration (5 min)

Explain to the class that a contour gauge allows you to duplicate the shape of an object without guessing the true contours.

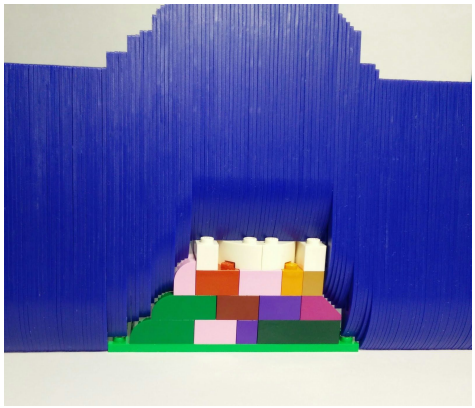
· Demonstrate how to use the contour gauge. Firmly grasp the gauge by the two yellow handles.

· Place the teeth of the gauge near the front edge of the structure.

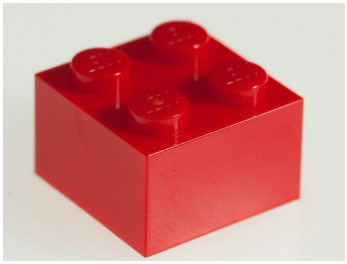
· Firmly pull down with the yellow handles. The gauge can rest freely on the structure. Ensure the teeth are fully engaged by pushing down on tops of individual teeth with a finger.

· Reset the gauge by flipping upside down, pull down on yellow tabs.

· Draw the outline shape of the gauge on copy paper. Walk around with the profile drawing, ensuring each person can see the profile. It does not matter if the top or the bottom of the gauge is outlined.



Guided (5 min)



Repeat the above process for the middle and back of your structure for a total of 3 profiles but have student volunteers demonstrate the process.

Independent (23 min)

In Part A of this activity, student pairs construct a structure that is no more than 8 (2x2) blocks long and 4 (2x2) blocks high. The structure should not be symmetrical. Students draw their structure from above, the front, and from the left side. Do not allow students to share their drawings with other groups.

In Part B of this activity, student pairs use the contour gauge to trace the profile from the front, middle, and back of their structure. Students compare their drawing in Part A to Part B. Do not allow students to share their drawings.

In Part C, pairs exchange their **Lego structure only with another group. The other group will draw their contours of the new structure from either the front, middle, or back without the aide** of the contour gauge. Once the task is complete, the two groups can compare their drawings.

Closure (7 min)

Have pairs of students share their experience through a combination of cold calling and volunteers. Select a few to report their responses to the questions. Clarify any misconceptions students may still have at this point.

Assessment:

Evaluate students' pre and post response on the definition of a profile.
Evaluate students' responses to questions throughout the activity sheet. Responses to task 10, 13, and 19 will provide insightful information about the student.
Students are assessed on their ability to create a profile of a Lego structure using a ruler and pencil without the contour gauge.

Profile Rubric

Category	3	2	1	0
Profile	Profile is clear and shows the entire Lego structure from left to right, includes measurements.	Profile mostly reflect the Lego structure and include some measurements.	Profile does not reflect Lego structure. Attempt is made to include measurements	Did not complete the task
Identification of Features	All major features are clearly identified	Most features are identified	Some of the features are identified	Did not identify features on profile.
Explanation of Features	Can explain all major features and use measurements to support explanation.	Can explain most of the features identified, however some support does not fully support justification	Attempt to explain the features however does not use measurements to justify explanation.	Can not explain features of the profile.


Resources:

http://pubs.usgs.gov/gip/TopographicMapSymbols/topomapsymbols.pdf
https://youtu.be/dA1J9kpi1nM
http://www.ucmp.berkeley.edu/fosrec/Metzger1.html

Extra Activities:

ELL students

- Display the definition of a topographic map at the front of room. Use an arrow or strings to connect the definition with a visual example of a topographic map. Use the phrase 'shape of the land' to help make the connection. Repeat this process for all important vocabulary in the lesson.
- Students trace the shape of a profile with their finger. Teacher helps to make the connection between shape of the land and the image of a topographic profile.
- Include the phonetic spelling of 'topographic' and 'profile' on their activity sheet.
- If necessary, partner weaker ELL student with a stronger ELL student and have them sort through multiple visual examples of a profile and list similarities, either in English or their native language. For homework, translate notes into English.

Struggling students

- Using natural objects found around school, have the student looks at an object closely. Draw it without looking at the paper. Draw the outside shape, without taking the pencil off the paper. Use their eyes to draw every detail. No peeking at the paper.

Advanced students

- Student create a topographic map of their Lego structure. Should the contour lines be circular?
- Provide students with a map of a popular hiking area. Students plan a hiking route that takes advantage of the terrain. Students are to defend their chosen route with information in regards to contour lines (where the path is steep or gentle), river crossings, valleys, ridges, and peaks. Students support their explanation with one or more topographic profiles of the hike.

For all Students Extension

- Build a 3-dimensional model of a landform using cardboard or foam and cut out the shapes.
- Make a clay model of a mountain and then use it to create a topographic map.
- Have students draw a map of their classroom. How would they draw a contour line for a desk or chair.
- Have students practice drawing and interpreting topographic profiles.

Misconceptions and possible obstacles

- Students may think that similar landforms all have the same profile. Students create profiles for multiple landforms that have similar characteristics. Students identify the similarities and differences.
- Students struggle with determining the elevation of contour lines. Only bench benchmark contours lines have written values. Have students count the contour lines by the listed contour interval. Use large arrows that point to the contour interval and have students circle the value.
- When reading a topographic map, students struggle with determining which direction is uphill. Students create profile of the area then draw an arrow pointing uphill on the map.

Acknowledgements:

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http://serc.carleton.edu/mathyouneed/slope/topoprofile.html
http://magician.ucsd.edu/~ltauxe/sio100/Final_handout2014.pdf
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http://www.thefreedictionary.com