Rubric for evaluating students’ watershed drawings

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| Watershed concept | 2 | 1 | 0 |
| Water flow on the surface | The image shows that elevation divides bodies of water and water flows downhill. | Image shows that water flows downhill or elevation divides bodies of water. | Model does not show water moving on elevation. |
| Watershed boundaries | The image shows that elevation serves as a boundary for watersheds. | The images show that watersheds have a boundary, but no relationship to elevation is shown. | The image does not include a boundary. |
| Nested systems | The image describes and shows that watersheds are nested within other watersheds. | The image shows or describes that watersheds are nested within other watersheds. | The image does not show nested watershed systems. |
| Inputs | The image shows multiple sources of water within the watershed. | The image shows one source of water within the watershed. | The image shows no sources of water. |
| Outputs | The image shows water flowing into a body of water (stream, river, or lake) from the land surrounding that body of water. | The image shows water flowing from part of the land surrounding a body of water, or part of the body of water with water flowing from all of the land that serves as its source. | The image does not show a relationship between land and a body of water. |
| Energy/gravity | The images describe and show that gravity is a force that moves water from high to low elevation. | The image describes or shows that gravity moves water from high to low elevation. | The image does not include reference to the role of gravity in the movement of water. |

Directions for teachers:

Worksheet one: ESRI digital elevation tools

Activity Time: 50–60 minutes

Materials (can be adjusted for table groups up to four)

• computers with internet access

• whiteboard and/or easel for showing and drawing images

Lesson goal: Students use models to analyze data to illustrate that elevation determines the direction of water flow.

Activity directions

Engage

1. Access the “Terrain Profile” web tool (*http://esriurl.com/elevation*) and ask students to navigate to a desired geographic location, preferably at the state-level view.

2. Have students make predictions, supported by justifications, about which direction the water will flow. In groups or individually, students record their predictions on paper. As a class, students record their predictions on the map projected on the whiteboard.

Experience

1. Identify a major river that is closest to the school and have students navigate to a section of the river that can be easily seen in the window viewer.

2. As a discussion topic, ask students which direction they think that the river flows in that area. Initiate smaller table group discussions first, asking students to use evidence from the maps that might help them to determine the direction of the river flow, then allow for class-wide sharing.

3. Activate the elevation tool by clicking on the “Measure” button (located just under the map on the right-hand side, represented by a ruler icon). Once activated, the teacher can click on several locations within the river boundary edge, forming a pathway. A quick double-click of the mouse button will complete the measurement pathway and send the information to the lower window to see the elevation profile.

4. Briefly demonstrate how hovering laterally along the bottom elevation profile window will make the red “X” move in both windows, so as to show the elevation associated with a specific part of the river.

5. Discuss where the highest elevation is located and the direction toward lower ground, and how that might affect the flow of water

6. Assign students different rivers within the whole state, asking them to identify the elevation points along the body of water and ultimately which direction the river flows.

7. On the projected map of the state, ask student groups to roughly draw in where the rivers are located and indicate with arrows which direction the water flows.

8. If time permits, students can draw vertical and horizontal lines across the state to determine the terrain profile and explain how that coincides with the direction of the rivers.

Summary (Evaluate)

1. Describe the terrain of your state and how that contributes to the flow of water.

2. What new or surprising information did you learn from this activity? (*Answers will vary, but might include discovering water that does not always flows south (a common misconception); rivers flow to lower elevation like major bodies of water; watersheds will flow into other larger watershed basins; and maps can help determine the boundaries of watersheds using elevation.*)

Application (Explain):

1. Where does the water in your river come from? How might the terrain profile affect what flows into your part of the river?

2. How can you predict the effects of pollution from a spill in a high elevation area?

Directions for teachers:

Worksheet two: Creating a clay model

Activity time: Two class periods of 50–60 minutes

Materials (can be adjusted for table groups up to four):

• modeling clay or play dough

• clay wire cutter (or sewing thread)

• blank laminated sheets of paper (11” × 17” or larger is best)

• dry erase markers

• two meter sticks

Directions

1. Begin with a discussion by posing a question about which direction water will travel if it lands from a rain cloud onto the ground. Have students consider which factors would influence where the water will go.

2. With the modeling clay, have groups shape a mountainous area that contains both a “steep” side and a “gradual” side.

3. Place the model on the laminated sheets and have students trace an outline of the base onto the paper with the dry-erase marker.

4. To ensure accuracy, have students create perpendicular dotted lines with a pencil or sharp object on the surface of the clay model to help maintain the alignment of the layers of the mountain after they are sliced. The dots on the dotted line should be numerous so that at least one appears per layer. Also, use the dry-erase markers to make marks on the laminated paper to line up with the perpendicular dotted lines on the clay.

5. Place two meter sticks on each side of the clay model. Two students should hold down the far edges of the stick. The width of the meter sticks will be the height of the slices of the clay model.

6. Slice the clay model with the clay wire cutter by carefully moving it laterally back and forth across the top of the meter sticks while slowly pulling ittoward you. It is critical that the wire is using the meter sticks as a guide for cutting a consistent height through the clay model.

7. Carefully remove the top layer of the clay model and set it aside temporarily (a student could hold it).

8. Remove the cut bottom layer and place to the side of the laminated sheet.

9. Realign the top layer using the dotted lines to match the perpendicular ones on the laminated sheet. Students will notice that the foundation of the model is smaller.

10. Carefully trace the outline of the new base with a dry-erase marker, creating a topographic line of higher elevation.

11. Repeat steps 6–10 until the clay model is shorter than the width of the meter sticks. Make sure to number each of the layers, in order, on the laminated sheet.

12. Reassemble the whole clay model and place it next to the topographic map just created by the outlines.

Summary

1. Describe the patterns you notice in the topographic lines for the different sides of the mountain (steep versus gradual).

2. Compare the 2-D topographic map to the 3-D clay model. Write in your own words what a single topographic line represents.

3. What does the location of the topographic lines relative to one another indicate?

4. How would your topographic map look different if you changed the height of your slices? Bigger slices? Smaller slices? How would changing the height of your mountain slices change the amount of information on your map?

Application

1. Looking at a paper topographic map (or ArcGIS), describe some of the features of an area of the landscape. Be specific about where you are looking on the map, and what evidence exists on the map to support your interpretation.



