Investigating Ocean Volume

Contributed by Julie Johnson, Science Communication Fellow

Objective: Students will explore volume across the Earth's ocean basins through observation of maps and hands-on learning. Students will reflect on the influences of depth and surface area in volumetric equations.

Materials:

- Ocean volume worksheet or Ocean Volume Quizlet (one-to-one)
  - https://quizlet.com/_3n73ka
- Various sized and shaped containers (i.e. Tupperware, pitcher, coffee mug, water bottle, thimble, measuring cups)
- Rice - enough to fill the various containers
- Large empty bin (to contain rice)
- Funnel
- Ocean Volume Poster Visual Aid (https://nautl.us/2joJhXj)

Volume of Ocean Basins Introduction:

Show the class the labeled Earth's Ocean Basins image (included on the student worksheet) and ask them to create a question that they find intriguing, "What do you wonder?" Facilitate a class discussion on topics of curiosity for your students. If the concepts of ocean depth or volume have not come up naturally, ask the class to consider the volume of the ocean.

Ask students to draft a list of the ocean basins from highest-to-lowest volume based on their observations of the image with no other research support. Compare lists guided by the discussion questions below.

Discussion Questions:

1. Does anyone have the same list?
2. Are many of the lists similar and in what way?
3. Why did other students choose differently?
4. What did students consider while creating their list?
5. What ocean basins were most difficult to compare?
6. What is volume?
7. What variables can affect volume?
8. What information would you have liked to have to make more educated lists?

Have students answer the questions on the student worksheet.

Volume as Rice Activity:

Option 1:

1. Students select three different shaped containers, examine them, and rank them as highest, medium, and lowest volume.
2. Fill the highest volume container to the top with rice.
3. Empty rice from the highest-volume container to the medium-volume container. Was it filled?
4. Pour the rice from the medium-volume container to the lowest-volume container.
5. If the student ranked the containers correctly, there should be surplus rice after each exchange.

Option 2:

1. Students select one large and one small container.
2. Ask students to estimate how many times larger they believe the large container is compared to the small container.
3. Once students have their estimate, fill the smaller container with rice and empty it into the large container.
4. Repeat as many times as needed to compare the true volume with the estimated volume.

Give students the Ocean Volume Data Table with detailed information on the surface area and depths of the ocean basins. Using this information, students will re-evaluate their estimated ranking. Students should make changes where they believe necessary.

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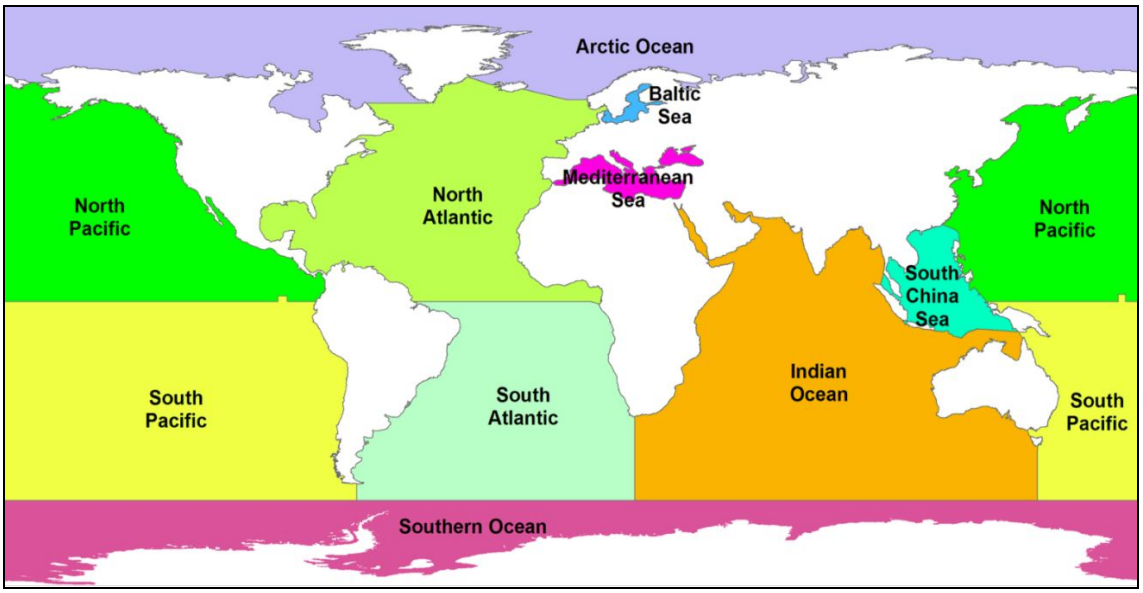
Student Worksheet

Earth's Ocean Basins



Graphic courtesy of [NOAA National Center for Environmental Information]

Part 1: Estimating Volume

Using the image above, create a list of the oceans from highest to lowest volume.

1. 6.
2. 7.
3. 8.
4. 9.
5. 10.

Part 2: Analyze Your Ranking

1. What did you consider when creating this list?

2. What ocean basins were challenging to rank compared to other basins? Why?

3. What types of information would you like to know to help create a more accurate ranking?

4. Define volume.

Part 3: Explore volume with rice

1. Comparing three volumes: Did you choose the larger, medium, and small containers correctly? What aspects of the objects did you consider while ranking them?

2. Estimating difference: How many times larger is the larger container compared to the smaller container? How did you decide on this estimate? How close was your estimate?

Part 4: Re-evaluate

Re-evaluate your original ocean basin ranking given the information on the Ocean Volume Data Table. Reorder your rankings if necessary.

Ocean Volume Data Table

Volumes of the World's Oceans from ETOPO1 model

NOAA National Center for Environmental Information

https://www.ngdc.noaa.gov/mgg/global/etopo1_ocean_volumes.html

	Surface Area[+] (km^2)	% Global Ocean Area	Average Depth (m)	Maximum Depth (m)
Arctic Ocean	**15,558,000**	**4.3**	**1205**	5567
Atlantic Ocean	**85,133,000**	**23.5**	**3646**	8486
Baltic Sea	*406,000*	*0.1*	*51*	*392*
Mediterranean	*2,967,000*	*0.8*	*1480*	*5139*
North Atlantic	*41,490,000*	*11.5*	*3519*	*8486*
South Atlantic	*40,270,000*	*11.1*	*3973*	*8240*
Indian Ocean	**70,560,000**	**19.5**	**3741**	**7906**
Pacific Ocean	**161,760,000**	**44.7**	**4080**	**10,803**
North Pacific	*77,010,000*	*21.3*	*4298*	*10,803[#]*
South Pacific	*84,750,000*	*23.4*	*3882*	*10,753*
South China Sea	**6,963,000**	**1.9**	**1419**	**7352**
Southern Ocean*	**21,960,000**	**6.1**	**3270**	**7075**
Total:	**361,900,000[¤]**	**100.0**	**3688**	**10,803**
+error estimates	0.10%			

Eakins, B.W. and G.F. Sharman, Volumes of the World's Oceans from ETOPO1, NOAA National Geophysical Data Center, Boulder, CO, 2010.

[+] Boundaries between oceans vary, making comparisons with other published estimates difficult.
[¤] Total surface area of Earth is 510,082,000 km^2. The oceans cover ~70.9%.
[*] Southern Ocean area and volume calculated from ETOPO1 Bedrock model version and include the Weddell and Ross Seas without ice cover.
[#] Deepest ocean depth is in the Marianas Trench, measured at 10,911 meters. Maximum depths from ETOPO1 model are not expected to exactly match the known measured maximum depths as ETOPO1 represents average depths over ~4 km^2 areas.