M3. The End of Oil

Teacher Notes

Overview

This activity focuses on a single mathematics problem to calculate the number of years until all of the oil on planet earth is gone. The problem is an outgrowth of a critical thinking discussion regarding the media, politicians, citizens on the street, etc. regarding how to get a true sense of what is happening regarding our oil supply—how critical the problem is, the effectiveness of various solutions, and various complex interdependent factors from economics to peace and security to climate change. Outcomes based on multiple scenarios for consumption growth rates and global reserves are explored. Through the mathematics students discover that conservation is more effective than supply side solutions, and in either case, alternatives for oil must be implemented immediately to avoid widespread economic disruption as well as environmental and climate concerns.

Topics

Mathematics: Application of geometric sum formulas, solving exponential equations, scientific notation, mathematical modeling, algebraic formula manipulation skills
Social Studies: Geopolitical issues regarding oil use—terrorism, economics, peak oil, political propaganda

Grade level

Grades 7-9: Application to these grades requires some special modifications as these students have not studied geometric sums or equation solving with logarithms. You could conduct the activity as discussion and presentation, leaving out the math calculation, however it is very realistic to have students do the calculations with extra support. You can lead them through the geometric sum formula and give them some simple examples to learn it. To solve the final equation use a guess and check strategy.
Grades 10-12: Students are prepared with all of the necessary math background to solve the problem.

Support activities

E2. What's Really True?

Activity Script

1. Discussion—How can we know when we will run out of oil?

Engage with students to find out what they have heard in the news regarding oil. Common issues and questions:

- Should we pursue offshore drilling?

- Should we drill in Alaska?
- Should we drill everywhere we can?
- Is the earth making more oil?
- Can we help solve our oil dependence problem by increasing our supply of oil (drilling and or pursuing shale oil and tar sands)?
- How can we even think about this—no one knows how much oil we have, we could have a huge amount!

2. The Beauty of Math—A voice of reason!

Suggest to students that mathematics can help us cut through the various types of rhetoric we hear and enable us to know for ourselves exactly what is going on.

a) Review the various parameters on the End of Oil student sheet with students. The first question that may arise is the fact that no one knows exactly how much oil is in the earth. This is absolutely true, so for this problem we will perform the calculation for one set of values (with students) and then view the values for a variety of other values (provided) for possible global reserves and growth rate of consumption. We will then compare the various values to see the *range of possibilities for the future of oil*

b) The problem: A reasonable estimate for the growth rate of global oil consumption is 3.5% per year. For the student calculation use the value of 2 trillion barrels of oil for the global reserves. Currently the world is consuming 31 billion barrels of oil each year, but of course, this figure is growing by about 3.5% each year. The structure of the equation will be formed from the following fundamental relationship for when the sum of all extractions reaches the global total:

total global reserves = sum of all extractions

The left side of the equation becomes the 2 trillion barrels and the right side becomes the geometric sum formula, where P_0 = 30 billion barrels/year, r=1.035 (this is the common ratio between any year and the year before it when growth is increasing by 3.5% each year), and n is the unknown number of terms. In this case, each term of the geometric series is a year's extraction. Students will solve for n. The solutions for various values are shown in the table below:

Years to the end of oil

Global annual consumption growth rates

Global reserves in trillions of barrels	0%	1.7%	3.5%	5%
2 (reasonable estimate)	66	45	35	30

4 (high estimate)	133	70	50	41
20 (impossible)	667	148	92	72

3. Debriefing, conclusion, and peak oil discussion

The first figure that the class will discover will be the solution to the problem that they calculated: 35 years. Do not share the other figures immediately. This figure is a realistic figure and it has some strong implications. Explain to students that it is actually not a useful number to know when all oil will be gone, because this actually cannot happen. As oil wells become depleted they do not yield oil as easily or quickly. In addition, global consumption is on the rise, and will be for the next several decades. As a result, there will come a time when the rate of global consumption surpasses the fastest rate at which oil can be extracted and processed. This point is referred to as *peak oil*. Peak oil is expected to occur well before the 35 year mark. Many believe it is very near, within the next several years. The eventual occurrence of Peak oil is an absolute certainty given the fact that we are consuming a finite quantity of oil. The only question is *when* it will occur. Given the degree to which all global infrastructure and economies are dependent on oil, this should be a significant cause for concern, and action.

This result can be alarming to many students. Conclude with students that this points out there is little time to waste to take action. But what action? A logical reaction would be to get more oil! Drill, drill, drill! But let's look at what would happen if we DOUBLED our oil discoveries to 4 trillion barrels. (Note: ANWAR in Alaska is expected to have at best 10 billion barrels total. The U.S consumes nearly 8 billion barrels each year). The 4 trillion barrel bonanza only gives us 15 more years of oil! Will that solve any problems?

Put up the rest of the values and explore the relationship between lowering the consumption growth rate and increasing supply. It is clear that lowering consumption buys more time than increasing supply. But in either case, this analysis drills in the reality (no pun intended) that we MUST move as quickly as possible to REPLACE oil as a fuel source. Indeed, this effort is at the core of the "green" movement, and it is a concern of economics and security.

What about climate change? This analysis sheds important on the climate issue. The message is clear: Whether or not one accepts the scientific consensus of anthropogenic climate change, we must take the same actions (transitioning off of oil) for a host of other reasons anyway!