COVID-19 Growth Rates

It is common to hear pandemic infection rates described as "exponential", and it is easy to see why. If each person with COVID-19 infects two other people, one can easily imagine what a graph of the pandemic might resemble.

Epidemiologists often describe the reproductive rate of a disease using the term R_0 which is pronounced as "R-naught". In the case above, $R_0 = 2$, meaning each person to become infected will, on average, pass the disease on to two more. In theory, any epidemic with an R_0 of less than one will fade away, while any with an R_0 greater than one will continue to increase, perhaps exponentially. The higher the R_0, the faster the growth. Estimates of R_0 for COVID-19 range from 2.2 (based on early data from Wuhan, China) to 4.5 in Europe during the Spring of 2020.

In this exercise, we will look at infection rates in the US during March 2020 and determine if the growth can best be modeled as linear, quadratic, or exponential. This will be followed by a discussion of what real-world factors are complicating the mathematics and how those factors might affect the curve.

1. Data on COVID-19 in the US can be obtained from the Centers for Disease Control here: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html If you are unable to find data on new cases in March of 2020, ask your teacher for assistance.
2. Construct a data table showing new and cumulative cases for each day of that month. A spreadsheet such as Excel or Google Sheets can be a handy tool for doing this.
3. Plot graphs showing new and cumulative cases.
4. Try fitting linear, quadratic, and exponential curves to your data. Assess the fit using R^2.
5. If, on the last day of March, you wanted to predict new or cumulative cases on April 15, would you model the growth using a linear, quadratic, or exponential curve? Explain your reasoning.
6. If the curve is "less exponential" than you expected, what real-world factors might explain why the growth rate wasn't higher? List as many as you can.

You may be interested to learn more about R_0. The following links would be a good place to start:

https://www.news-medical.net/news/20200510/Reproduction-number-of-COVID-19-and-how-it-relates-to-public-health-measures.aspx

https://www.weforum.org/agenda/2020/05/covid-19-what-is-the-r-number/