

## Lesson Plan: Teaching Polynomial and Logistic Differentiation using Global Wind Energy Production Data

As a **high school** or **undergraduate Mathematics** teacher, you can use this set of computer-based tools to help you in teaching introductory **differential calculus** and specifically about **polynomial and logistic differentiation** and the **use of the Quotient (or Product) Rule**.

This lesson plan will allow you to teach **polynomial and logistic differentiation** using a **hands-on computer-based classroom activity** that includes **wind energy production data of several countries from 1980 to 2016**. In the context of global warming due to carbon emissions from fossil fuel, harnessing a clean renewable source of energy like wind power is increasing across the globe and can provide a potential solution to reducing our greenhouse gas emissions. This activity includes a **set of inquiry-based questions** that will enable your students to apply their understanding of **polynomial and logistic differentiation** and apply the **Quotient (or Product) Rule** to describe the rates of increase of wind energy production over time in countries such as China, Spain, USA, and the World.

Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in **Mathematics**.

Use this lesson plan to help your students find answers to:

- What are differentiating functions?
- Describe polynomial and logistic differentiation using examples.
- How has the rate of global wind energy production changed since 1980?
- How do the rates of wind energy production in select countries (from the given datasets) differ from that of the World?
- Define a function for the rate of increase of the World's wind energy production to meet its entire energy requirement.

[About the Lesson Plan](#)

**Grade Level:** High School, Undergraduate

**Discipline:** Mathematics, Earth Sciences

**Topic(s) in Discipline:** Polynomial and Logistic Differentiation; Quotient or Product Rule

**Climate Topic:** Energy, Economics and Climate Change, Climate Mitigation and Adaptation

**Location:** Global, China, Spain, USA

**Access:** Online, Offline

**Language(s):** English

**Approximate Time Required:** 50-60 min

# 1 Contents

## 1. Teaching Module (30 min)

A teaching module to explain differentiating functions, polynomial and logistic differentiation, differentiation rules and the use of the Quotient or Product Rule.

This can be accessed at:

<https://openstax.org/books/calculus-volume-1/pages/3-3-differentiation-rules>

## 2. Classroom Activity (20 min)

A classroom activity to apply understanding of polynomial and logistic differentiation using datasets of various countries' wind energy production over time (1980-2016).

This can be accessed at:

<http://sustainabilitymath.org/calculus-materials/>

## 3. Visualizations (10 min)

A set of interactive visualizations using similar datasets to better understand the distribution of and changes in wind energy production across the globe in recent times.

These can be accessed at:

- <https://resourcewatch.org/data/explore?zoom=2&lat=25.387728722075092&lng=76.99220895767213&basemap=dark&labels=light&layers=%255B%257B%2522dataset%2522%253A%2522a86d906d-9862-4783-9e30-cdb68cd808b8%2522%252C%2522opacity%2522%253A1%252C%2522layer%2522%253A%2522e7ff7ca9-27f3-440b-9633-a5fd477f3283%2522%257D%255D&page=1&sort=most-viewed&sortDirection=-1>
- <https://ourworldindata.org/grapher/wind-energy-consumption-terawatt-hours-twh>

#### 4. Suggested questions/assignments for learning evaluation

- What are differentiating functions?
- Describe polynomial and logistic differentiation using examples.
- How has the rate of global wind energy production changed since 1980?
- How do the rates of wind energy production in select countries (from the given datasets) differ from that of the World?
- Define a function for the rate of increase of the World's wind energy production to meet its entire energy requirement.

## 2 Step-by-step User Guide

Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

## 1. Topic introduction and discussion

Use the teaching module, '[Differentiation Rules](#)' by OpenStax, Rice University, to teach differentiating functions, differentiation rules, and polynomial or logistic differentiation. Navigate to the sub-sections within the module to explain the types of differentiating functions and the application of the Quotient or Power Rule. Use the in-built practice exercises and quizzes to evaluate your students' understanding of the topics.

This can be accessed at:

<https://openstax.org/books/calculus-volume-1/pages/3-3-differentiation-rules>

## 2. Extend understanding

Use the classroom activity, '[Wind Energy by Selected Countries and World](#)' from Sustainability Math by Thomas J. Pfaff, Professor of Mathematics, Ithaca College, USA, to enable your students to apply their understanding of polynomial or logistic differentiation using datasets from the International Energy Agency (IEA). This classroom activity includes datasets of several countries' wind energy production (including the World's cumulative data) from 1980 to 2016. This data is provided in an Excel spreadsheet. The classroom activity also includes a Word document that contains directions on how to use different mathematical methods on the data provided. It further includes questions that you may wish to use in your classroom to explain differentiating functions to initiate a discussion on the rate of increase in global wind energy production in several countries such as China, Spain, and USA in recent times. Direct your students to download the Excel file (with datasets) and the Word document (with directions to use the datasets and a set of questions to analyze the datasets). The documents also include datasets of several other countries that may be used for this activity. Proceed with the classroom activity and encourage your students to answer the questions by applying their understanding of differentiating functions and the Quotient (or Power) Rule. This activity also includes links to readings to help explain to your students the basics of wind energy production and its environmental impacts.

This can be accessed at:

<http://sustainabilitymath.org/calculus-materials/>

### 3. Discuss further

Use the visualizations, '[Wind Power Plants by Capacity \(MW\)](#)' by World Resources Institute (WRI) and '[Wind energy generation, 2018](#)' by Our World in Data to discuss about the current capacity and distribution, and increase in capacity of global wind energy production for the years 1965-2018. Finally, discuss how the increase in the World's wind energy production could help reduce carbon emissions and mitigate global warming.

These can be accessed at:

- <https://resourcewatch.org/data/explore?zoom=2&lat=25.387728722075092&lng=76.99220895767213&basemap=dark&labels=light&layers=%255B%257B%2522dataset%2522%253A%2522a86d906d-9862-4783-9e30-cdb68cd808b8%2522%252C%2522opacity%2522%253A1%252C%2522layer%2522%253A%2522e7ff7ca9-27f3-440b-9633-a5fd477f3283%2522%257D%255D&page=1&sort=most-viewed&sortDirection=-1>
- <https://ourworldindata.org/grapher/wind-energy-consumption-terawatt-hours-twh>

### 4. Questions/Assignments

Use the tools and the concepts learned so far to discuss and determine answers to the following questions:

- What are differentiating functions?
- Describe polynomial and logistic differentiation using examples.
- How has the rate of global wind energy production changed since 1980?
- How do the rates of wind energy production in select countries (from the given datasets) differ from that of the World?
- Define a function for the rate of increase of the World's wind energy production to meet its entire energy requirement.

## 3 Learning Outcomes

The tools in this lesson plan will enable students to:

- learn about polynomial and logistic differentiation, and the use of the Quotient or Product Rule.
- describe the rules for differentiating functions.
- apply differentiating functions to compare the rates of increase of wind energy production by several countries (from given datasets).
- discuss the importance of increase of renewable sources of energy such as wind power to reduce global warming.

## 4 Credits/Copyrights

All the teaching tools in our collated list are owned by the corresponding creators/authors/organizations as listed on their websites. Please view the individual copyright and ownership details for each tool by following the individual links provided. We have selected and analyzed the tools that align with the overall objective of our project and have provided the corresponding links. We do not claim ownership of or responsibility/liability for any of the listed tools.

### 1. Teaching Module; 'Differentiation Rules'

[OpenStax](#) by Rice University.

### 2. Classroom Activity; 'Wind Energy by Selected Countries and World'

Provided by [Sustainability Math](#) by Thomas J. Pfaff, Professor of Mathematics, Ithaca College, USA.

### 3. Visualizations

'Wind Power Plants by Capacity (MW)' by [World Resources Institute \(WRI\)](#)

'Wind energy generation, 2018' by [Our World in Data](#)