Lesson Plan: Teaching Differentiating Functions (Logistic and Exponential) using Global Solar 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;** specifically, about **differentiating logistic and exponential functions** and the **use of the Quotient (or Product) Rule**.

This lesson plan will allow you to teach **differentiating functions- logistic and exponential,** using **a hands-on computer-based classroom activity** that includes **data of photovoltaic (solar) energy production of several countries from 1990 to 2016**. In the context of global warming due to carbon emissions from fossil fuel, harnessing a clean renewable source of energy like solar power is increasing across the globe and can be a potential solution in reducing our greenhouse gas emissions. This activity includes **a set of inquiry-based questions** that will enable your students to apply their understanding of **logistic and exponential functions** and apply the **Quotient (or Product) Rule** to describe the rates of increase of photovoltaic energy production over time in countries such as Germany, Italy, 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?
- Distinguish between logarithmic, exponential, and logistic differentiating functions.
- How has the rate of global solar energy production changed since 1990?
- How do the rates of solar 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 solar 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: Differentiating Functions- Logarithmic, Exponential, Logistic; Quotient or Product Rule

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

Location: Global, Germany, Italy, USA

Access: Online, Offline

Language(s): English

Approximate Time Required: 50-60 min

1 Contents

cdb68cd808b8%2522%252C%2522opacity%2522%253A1%252C%2522layer%2522%253A%2522d0a1ae43-6a14-443b-86d6-d01dfac842fa%2522%257D%255D&page=1&sort=most-viewed&sortDirection=-1

- https://ourworldindata.org/grapher/solar-energy-consumption

4. Suggested questions/assignments for learning evaluation

- What are differentiating functions?
- Distinguish between logarithmic, exponential, and logistic differentiating functions.
- How has the rate of global solar energy production changed since 1990?
- How do the rates of solar 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 solar 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, 'Exponential and Logarithmic Functions' by University of Nebraska-Lincoln, to introduce the concept of differentiating functions. Navigate to the sub-sections within the module to explain logarithmic, exponential, and logistic 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://mathbooks.unl.edu/Calculus/explog.html

2. Extend understanding

Use the classroom activity, 'Country Photovoltaic Energy Production (and more)' from Sustainability Math by Thomas J. Pfaff, Professor of Mathematics, Ithaca College, USA, to enable your students to apply their understanding of differentiating functions using datasets from the International Energy Agency (IEA). This classroom activity includes datasets of several countries' photovoltaic energy production (including the World's cumulative data) from 1990 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 solar energy production in several countries such as Germany, Italy, 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 logistic and exponential differentiating functions and the Quotient (or Power) Rule. This activity also includes links to readings to help explain to your students the importance of solar energy production to meet the world's energy requirements and discuss why this mode of energy production has been slow to increase across the world.

This can be accessed at:

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

3. Discuss further

Use the visualizations, 'Solar Power Plants by Capacity (MW)' by World Resources Institute (WRI) and 'Solar energy generation, 2018' by Our World in Data to discuss about the current capacity and distribution, and increase in capacity of global solar energy production for the years 1965-2018. Finally, discuss how the increase in the World's solar 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%2522d0a1ae43-6a14-443b-86d6-d01dfac842fa%2522%257D%255D&page=1&sort=most-viewed&sortDirection=-1

- https://ourworldindata.org/grapher/solar-energy-consumption

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?
- Distinguish between logarithmic, exponential, and logistic differentiating functions.
- How has the rate of global solar energy production changed since 1990?
- How do the rates of solar 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 solar energy production to meet its entire energy requirement.

3 Learning Outcomes

The tools in this lesson plan will enable students to:

- learn about differentiating functions and the use of the Quotient or Product Rule.
- distinguish between logarithmic, exponential, and logistic functions.

- apply differentiating functions to describe the rate of increase of solar energy production for several countries (from given datasets).
- discuss the importance of increase of renewable sources of energy such as solar energy to reduce global warming.

4 Credits/Copyrights

1. Teaching Module; 'Exponential and Logarithmic Functions'

By Open Source Textbooks at The University of Nebraska-Lincoln.

2. Classroom Activity; 'Country Photovoltaic Energy Production (and more)'

Provided by Sustainability Math by Thomas J. Pfaff, Professor of Mathematics, Ithaca College, USA.

3. Visualizations

'Solar Power Plants by Capacity (MW)' by World Resources Institute (WRI)

'Solar energy generation, 2018' by Our World in Data