

## Lesson Plan: Teaching Introductory Statistics (Linear Regression) using Global Temperature Anomalies Data

As a **high school** or **undergraduate Mathematics** teacher, you can use this set of computer-based tools to help you in teaching introductory **statistics** and specifically **linear regression**.

This lesson plan will allow you to teach **introductory statistics** through a **linear regression** assignment. The lesson plan includes a **hands-on computer-based classroom activity** to be conducted on a **dataset of Global Temperature Anomalies (1850-2017)**. This activity includes a **set of inquiry-based questions** that will enable your students to apply their understanding of **scatter plots, regression equations, correlation coefficients, linear regression, and confidence intervals for slopes**.

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:

- Use an example to describe linear regression analysis.
- Determine the difference in the confidence intervals for the slopes for two 30-year period datasets- 1850-1880 (beginning of industrial age) and 1987-2017 (last datapoint). What does the result suggest?
- Use linear regression analyses to describe how global temperatures have changed from 1850 (pre-industrial)- 2017 (last datapoint).
- Discuss reasons for global warming and its impact on Earth's climate.

### About the Lesson Plan

**Grade Level:** High School, Undergraduate

**Discipline:** Mathematics

**Topic(s) in Discipline:** Scatter Plots, Correlation Coefficients, Regression Equations, Linear Regression, Confidence Intervals for Slopes

**Climate Topic:** Climate and the Cryosphere, Climate Variability Record

**Location:** Global

**Access:** Online, Offline

**Language(s):** English

**Approximate Time Required:** 60 min

# 1 Contents

## 1. Teaching Module (25 min)

A teaching module to explain the basics of scatter plots, correlation coefficients, regression equations, and linear regression.

This can be accessed at:

High School: <https://openstax.org/books/introductory-statistics/pages/12-introduction>

Undergraduate: <http://www.mit.edu/~6.s085/notes/lecture3.pdf>

## 2. Video micro-lecture (~7 min)

A video micro-lecture to explain the confidence interval for the slope of a regression line.

This can be accessed at:

<https://www.khanacademy.org/math/ap-statistics/inference-slope-linear-regression/inference-slope/v/confidence-interval-slope>

## 3. Classroom Activity (20 min)

A classroom activity to apply understanding of linear regression using a dataset of the Global Temperature Anomalies (1850-2017).

This can be accessed at:

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

#### 4. Visualization (5 min)

An interactive visualization of the given dataset of Global Temperature Anomalies (1850-2017).

This can be accessed at:

<https://ourworldindata.org/grapher/temperature-anomaly>

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

- Use an example to describe linear regression analysis.
- Determine the difference in the confidence intervals for the slopes for two 30-year period datasets- 1850-1880 (beginning of industrial age) and 1987-2017 (last datapoint). What does the result suggest?
- Use linear regression analyses to describe how global temperatures have changed from 1850 (pre-industrial)- 2017 (last datapoint).
- Discuss reasons for global warming and its impact on Earth's climate.

## 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, '[Introduction-Linear Regression and Correlation](#)' by OpenStax™, Rice University (for High School level) or '[Chapter-3: Linear Regression](#)' provided by Ramesh Sridharan, Massachusetts Institute of Technology (for Undergraduate level), to introduce these topics of basic statistics. Navigate to the sub-sections within the module to the basics of scatter plots, correlation coefficients, regression equations, and linear regression. Use the in-built practice exercises and quizzes to evaluate your students' understanding of the topics.

These can be accessed at:

High School: <https://openstax.org/books/introductory-statistics/pages/12-introduction>

Undergraduate: <http://www.mit.edu/~6.s085/notes/lecture3.pdf>

## 2. Develop the topic further

Use the video micro-lecture, '[Confidence interval for the slope of a regression line](#)' by Khan Academy to explain this inference about a slope. Navigate to the next subsection and direct your students to solve practice problems on the confidence interval of slope of a regression line to enable better understanding of the topic.

This can be accessed at:

<https://www.khanacademy.org/math/ap-statistics/inference-slope-linear-regression/inference-slope/v/confidence-interval-slope>

## 3. Extend understanding

Use the classroom activity, '[Global Temperature Anomalies](#)' from Sustainability Math by Thomas J. Pfaff, Professor of Mathematics, Ithaca College, USA, to enable your students to apply their understanding of linear regression and confidence intervals of slopes of regression lines by using a dataset developed by Climatic Research Unit (University of East Anglia) in conjunction with the Hadley Centre (UK Met Office). This classroom activity includes a dataset of Global Temperature Anomalies observed from 1850 to 2017. These observations are taken as deviations from the Global Average Mean temperature for the period 1961-1990. This data is provided in an Excel spreadsheet that you may use in your classroom to explain the mathematical functions and methods. Direct your students to download the Excel file (with dataset) and proceed with

the classroom activity. Encourage your students to answer topical questions by applying their understanding of scatter plots, correlation coefficients, regression equations, linear regression, and confidence intervals of slopes of regression lines. Use the regression analyses performed to initiate a discussion on the increase in average global temperatures from pre-industrial time (1850) to the last data point (2017) due to anthropogenically forced Global Warming (links to explanatory notes given within the tool).

This can be accessed at:

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

#### 4. Discuss further

Use the interactive visualization of the same dataset, '[Average temperature anomaly, Global](#)' by Our World in Data, to encourage discussion amongst your students about the changes in the average global temperatures from the years 1850-2017. Discuss how these changes suggest that the planet is warming and therefore, could be impacting Earth's climate.

These can be accessed at:

<https://nsidc.org/arcticseaicenews/charctic-interactive-sea-ice-graph/>

#### 5. Questions/Assignments

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

- Use an example to describe linear regression analysis.
- Determine the difference in the confidence intervals for the slopes for two 30-year period datasets- 1850-1880 (beginning of industrial age) and 1987-2017 (last datapoint). What does the result suggest?
- Use linear regression analyses to describe how global temperatures have changed from 1850 (pre-industrial)- 2017 (last datapoint).
- Discuss reasons for global warming and its impact on Earth's climate.

## 3 Learning Outcomes

The tools in this lesson plan will enable students to:

- learn about linear regression and correlation
- understand linear regression equations and related terms such as correlation coefficients
- use linear regression analyses and confidence intervals of slopes of regression lines to describe global temperature anomalies from pre-industrial to recent times (1850-2017)
- discuss how these changes suggest that the planet has warmed significantly since the beginning of the industrial age

## 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; 'Introduction-Linear Regression and Correlation'

Provided by [OpenStax™](#), Rice University.

### 2. Teaching Module; 'Chapter 3: Linear Regression'

Provided by [Ramesh Sridharan](#), MIT from '[Statistics for Research Projects](#)'.

**3. Video micro-lecture; 'Confidence interval for the slope of a regression line'**

Presented by [Khan Academy](#).

**4. Classroom Activity; 'Global Temperature Anomalies'**

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

**5. Visualization; 'Average temperature anomaly, Global'**

Developed by [Our World in Data](#).