

LESSON PLAN: Lying with Graphs

OVERVIEW: In this activity, students begin by assessing various graphics and classifying whether the graphs depict quantitative or qualitative data. They answer questions regarding what the graphs are saying, as well as determine how changes in a graph may distort the picture. Students generate Excel graphs based on real-world data, including pie charts, bar graphs, and line charts. Critical questions are asked regarding the student-generated graphs to enhance their skill in accurately interpreting graphed information. Lastly, students will continue analyzing misleading graphs, make claims regarding the misrepresentation of the graphs, and communicate their justifications to their peers via a homework assignment.

MATERIALS NEEDED TO CARRY OUT THE LESSON

- In-Class Activity Worksheet
- Laptop with Excel
- Access to the internet

CONCEPTS TO BE LEARNED/APPLIED

- Students will understand which graphs are created from quantitative data and which graphs are created from qualitative data.
- Students will understand how to correctly interpret and gain information from the graphs.
- Students will understand how to generate graphs using Excel from real-life data.
- Students will understand how to determine when graphs have been distorted and show a biased picture.

INSTRUCTIONAL PLAN

The instructor will begin by presenting the following vocabulary and concepts.

First, make sure the students understand that it is important to know where the data comes from. Secondly, it should be clear which type of sampling method was used to obtain the units from the recorded data. There is a CoRD that goes over the concept of bias in sampling that you may want to consider using as part of the statistical literacy component of your class.

For a very brief introduction to these topics consider going over the following information regarding sampling methods and data accuracy.

Sampling Methods: Questions to Consider

- Was a **census**, the entire population, used to obtain the data?
- Was a **representative sample** used? The sample (the part of the data being studied) should be representative of the whole group. For example, if a survey only samples teenagers but makes claims about all adults, the results might not be valid for all adults.
- Were the results of the study **generalized**? If so, was it appropriate to generalize the results to a larger group or a different context?

Data Accuracy: Questions to Consider

- Is the data shown in the graph accurate and up to date? Outdated data can lead to incorrect conclusions.
- Was the data collected from a reliable source?

If you do not have time to cover the aforementioned CoRD on statistical literacy, we encourage you to check out the short, pre-class assignment in the first activity of the Statistical Literacy CoRD which includes an introduction to misinformation in the news and online.

Data consists of observations such as measurements, genders, and survey responses that have been collected.

Variables are characteristics of the unit/individual such as weight, color, yield, etc.

A **qualitative (or categorical or attribute) variable** places units or individuals into groups. Some examples are political party, race, and color.

A **quantitative (or numerical) variable** consists of numbers representing counts or measurements. Some examples are age, weight, and miles per gallon.

Optional vocabulary: Quantitative variables can be discrete or continuous. Typically, **discrete variables** are countable and distinct, such as the number of eggs a chicken lays. **Continuous variables**, however, can take on an infinite number of values within a range such as weight, distance, time, etc.

The **distribution** of the variable describes what values the data takes and how often it takes those values.

Various graphs can be used to describe the distribution of variables. This activity looks at graphs that are commonly used online. The three types of graphs we will focus on are bar graphs, pie charts, and line charts.

Emphasize to students that all graphs will show numbers, but that does not mean the underlying variable is quantitative. They need to think about what data was selected from the units or individuals being studied. For example, if one wanted to create a graph of the percentage of people who voted for various candidates, each person would have been asked, "Who did you vote for?", and their response would be a person's name and not a number. Consequently, the data would be qualitative. The people would be put into groups based on who they voted for.

Students are now ready to start working on the worksheet in groups.

When students are finished with the activity, make sure they have grasped the importance of asking themselves the following questions when looking at graphs online.

- Does the scale used for the y-axis distort the appearance of the graph causing the difference between the two groups to be accentuated?
- Does the graph present the information accurately? For example, for a pie chart, is the data represented as a percentage so it is easier for the reader to interpret?
- Does the graph show the entire picture? For example, for line graphs showing trends over time, does the timeline utilized in the graph show the entire picture or is it cut off to distort what is happening?

Optional Talking Points: Additional Questions to Consider When Reading Graphs

- Do the graphs include easy-to-interpret labels? Missing labels or misleading titles can distort what the data is showing.
- Does the graph show differences between values (additive) or ratios (multiplicative)? How does this affect the interpretation of the data?
- Does the graph misrepresent the data used? For example, is a pie chart used when a bar chart would be clearer? Is a 3D graph used to distort the true proportions?

Recommended Homework Assignment

Create the following discussion post for the students.

For this assignment, you need to post a picture of a graph you found online that distorts data to promote a certain viewpoint. Make sure you reference where you found the graph. Explain to your classmates how the data was distorted. As part of the assignment, you need to respond to two of your peers' posts.

Note: Students can also present their findings in class if that is the preferred method of communication and if there is class time available.

MIP COMPONENTS OF INQUIRY

Active Learning

This activity will engage students as they learn about various types of graphs. Students will explore graphs often used in media such as pie charts, bar graphs, and line graphs. The activity will begin with students analyzing various graphs by selecting the variable and determining whether the data is quantitative or qualitative. Students will then use Excel to create their own graphs representing real-world data. In doing so, they will need to select the appropriate type of graph for the given data set. They will then perform the actions needed to create the graph in Excel. Moreover, as students analyze the graphs throughout the activity, they will evaluate whether the graph accurately portrays the data, as well as interpret what the graph is saying.

Meaningful Applications

Interpreting data is an important skill for students to have so that they can extract meaningful insights from that data. Proficiency in this skill is crucial in today's data-rich environment. Students will be asked leading questions to guide them through the thought process needed to competently interpret graphs. Through these investigations, students will be asked to make and justify claims with questions such as:

- From this graph, how could you figure out...? Justify your response.
- Which graph more accurately depicts the data? Why?
- When reading line graphs that show a trend over time, what do you need to pay attention to?

Moreover, students will explore real-world graphs and determine (with justification) how the graphs may have been distorted to show a biased viewpoint.

Academic Success Skills

This activity will foster students' construction of their identities as learners by engaging them in "real-world" problems relevant to their current and future lives. As indicated in Hidayati (2020), we often see

graphics or data in major news stories, as well as statistical information presented in political and economic policies.

This activity will use Excel to streamline computations and allow students to visualize differing representations of data via graphs. This use of technology allows students to focus on grasping the underlying concepts as opposed to computations. This approach not only promotes the development of academic success skills, such as technological proficiency, but also facilitates a deeper understanding of statistical analysis.

Critical thinking is an important skill for students to have and such thinking is encouraged throughout this activity by questions similar to those mentioned in the “Meaningful Applications” section.

Lastly, by engaging students in real-world scenarios and empowering them to construct their identities as confident, capable learners, we aim to foster a more meaningful learning experience that will empower them to become more informed citizens.

Reference

Hidayati, N.A., Waluya, S.B., Rochmad, & Wardono. (2020). Statistics literacy: What, why, and how? *Journal of Physics: Conference Series* 1613.