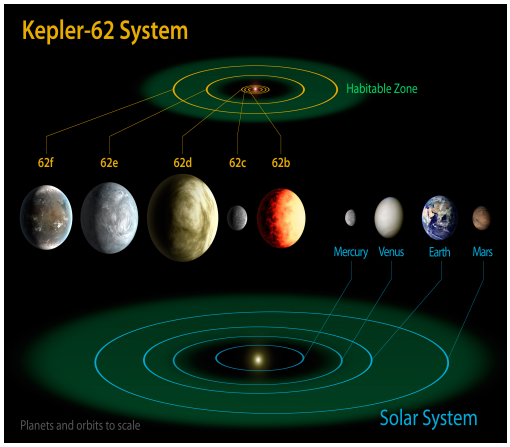
1. Objective & Introduction

Today's lesson objective is:

Students will develop an explanation of a relationship from a set of data.



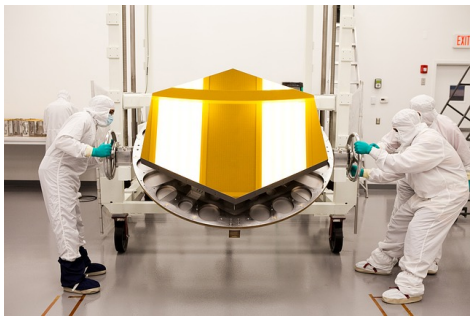
You've identified a problem and completed background research, collected and analyzed your data, and stated a conclusion for your science investigation. But you're not done yet! We still have to explain the relationship between the independent and dependent variables seen in the data. This is where you can finally provide your opinion regarding why the things that happened did so ... in the form of an inference.

You will have to be able to match different types of relationships to graphs. Flash cards may be a great strategy to help with this type of memorization. You will also be asked to learn a new process. Open your digital notebook and do some prewriting on what you already know about finding relationships between objects. Think about the relationships that you already know about. Jot those down and think about what they have in common. Notes or graphic organizations will help with this type of information. Can you think of any other strategies?

2. Identifying Variables

Once the problem has been identified and researched, the data has been collected and analyzed, and the conclusion stated, scientists can provide answers that explain the reasons for what happened during the investigation. This means that the scientists can finally provide their point of view as to why a particular relationship was seen between the variables. Of course, this point of view must be tied closely to the research done on the topic. This type of opinion, which is based on prior knowledge and observations, is known as an inference. But before we can look at variables to determine the relationships between them, we need to review variables.

A variable is any factor or thing that can be measured, changed, or controlled during an experiment. There are three types of variables: a control variable, an independent variable, and a dependent variable. The independent variable is usually the factor or thing we are actually testing in the hypothesis wording. There can be only one independent variable in any experiment. If there is more than one, then the experiment will not be a valid or reliable scientific investigation. The dependent variable is the one that will respond to whatever changes we make to the independent variable. Control variables are variables that must be kept constant throughout the investigation and are not allowed to change.

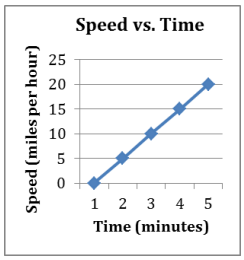


Let's identify the variables in the following hypothesis.

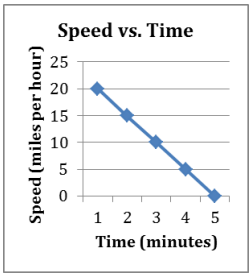
Hypothesis: Plants placed in the shade will not grow to normal height.

The growth of the plants is the dependent variable because it depends on the amount of light. The amount of light is the independent variable because this is what we have chosen to test. The control variables will be all other variables that we would need to keep the same throughout the investigation. Examples of control variables for this experiment would include the amount of water, time of day the plants are watered, the type of soil, and the amount of fertilizer.

Now that we remember all that we need to know about variables, let's take a look at relationships between variables that may be determined during the analysis of the data.

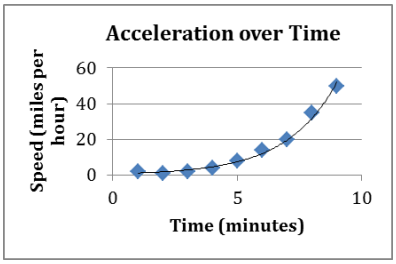


Directly proportional: This describes a relationship in which as one variable increases, the other variable also increases. An example would be the positive slope graph below. It shows that as the time increased, the speed also increased.



Inversely proportional: This term describes the exact opposite of directly proportional. In other words, this term means that as one variable increases, the other variable decreases. An example would be the negative slope graph below. It shows that as the time increased, the speed of the car decreased.

Exponential: This term describes a relationship where there is not a 1-to-1 increase or decrease, but one variable increases or decreases by a number that is greater than 1 over a period of time. The slope of this graph is not a line, but is shaped like a curve and can be positive or negative. This example shows that the speed increased at a quicker rate for each minute of time.



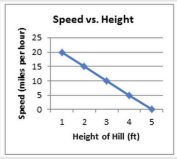
This graph shows a direct exponential relationship. However, similar to the negative slope, a negative curve will show an inverse relationship.

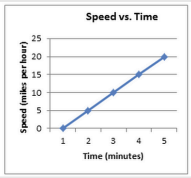
Before we go any further, let's do a quick vocabulary check by completing the following activity. It is very important to understand the terms and what they represent prior to moving forward in this lesson.

Match the graph and description to the correct term.

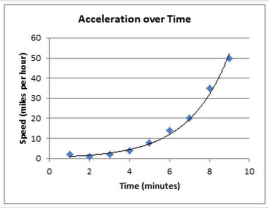
	Graph	Description
directly proportional		
inversely proportional		
exponential		

This term describes a relationship where there is not a 1 to 1 increase or decrease, but one variable is increasing or decreasing by a factor that is greater than 1 over a period of time.





This describes a relationship in which one variable increases as the other variable decreases.



This relationship in which one variable increases as the other variable increases.

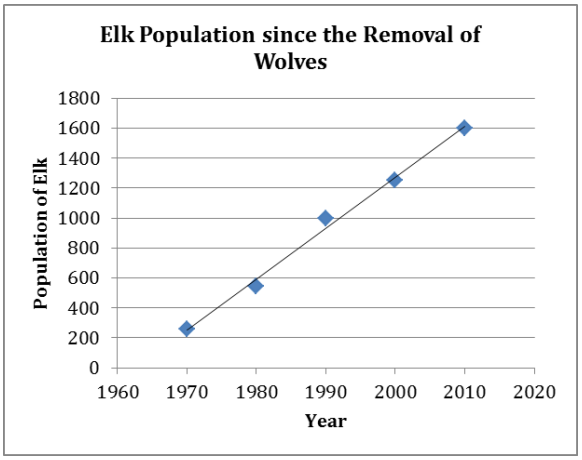
3. Using Background to Determine a Relationship

Now we will add a bit of background research to help us be able to explain the relationships in the data.

Take a look at this example of a student's science project on the changes in the elk population in the national park located in her area.

Background Research:

A student was studying the changes in the population of elk for her science project. At one point, she read that the number of elk drastically decreased in the local national park. In 1970, the park officials decided that it would be best to remove the population of wolves in an effort to preserve the elk population. As a result of the removal of wolves, Yellowstone also experienced other changes. Many open fields that were once green vegetation were turning brown and dying due to overgrazing by large animals, such as elk and deer. This also affected the number of small animals, such as beavers, and insects. She used this research to formulate the hypothesis below. She collected and recorded elk populations since the removal of wolves from the national park. She graphed the data in the graph shown below in order to determine the relationship between the elk population and wolf population over the past 60 years.



Hypothesis: As the wolf population decreases, the elk population increases.

We also see that the independent variable is the year and the dependent variable is the population of elk. An easy way to remember the variables when looking at a scientific graph is that the independent variable is graphed on the x-axis and the

dependent variable is graphed on the y-axis.

Now, let's determine the relationship between the variables and then explain why it may be this way.

- **Look at the graph to determine the relationship:** We see that the slope of the graph is a straight line and is positive. This means that there is a directly proportional relationship between the population of the elk each year between 1970 and 2010.
- **Determine what the relationship of the data tells us about the variables:** An easy way to complete this step is to make a statement based on what we see from the evidence patterns. In this case, we can state this by saying that the population of elk steadily increased between 1970 and 2010.
- **Refer to the background data to find a possible reason:** When we re-read this, we see that the population of wolves was removed in 1970 in hopes of allowing the elk population to increase.
- **Infer what you think is the reason for the statement made in step 2 based on the background research:** It can be inferred that the elk population increased because the wolf population was removed. Without the wolf predator in the national park, the elk population was able to live long enough to reproduce and increase in number.

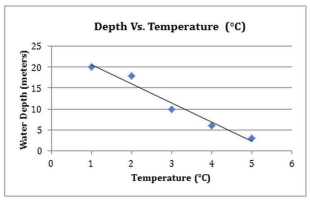
Do you have a different explanation? The cool thing about this part is that it is okay if you do, just as long as your explanation is tied to the background research and evidence gathered during the investigation!

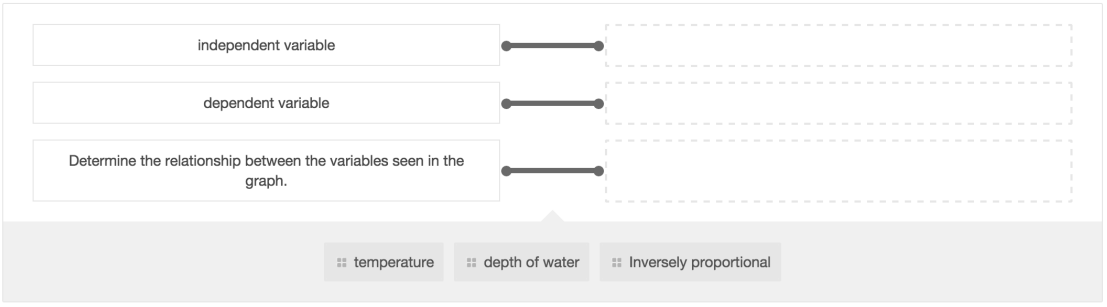
Do you think you're ready to try one on your own? Of course you are! Just follow the same steps we did in the example above.

Determine and explain the relationship between the variables by matching the correct statements.

Background research: Sunlight and heat only penetrate the surface of any body of water. In any dark area of the water, the temperatures will be lower. The farther underneath the surface of the water, the lower the temperature will be.

Hypothesis: As the depth under the surface of the water increases, the temperature will decrease.





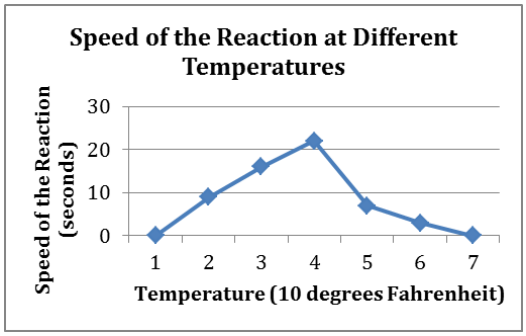
4. Relationships Between Variables

Sometimes the relationship between the variables is not as simple as the examples we've worked with so far. Scientists may have a graph that shows different relationships between the independent and dependent variables at different points during the investigation. Read the following scenario and then analyze the graph.

Karla was studying how different temperatures could speed up or slow down the speed of a chemical reaction in her science class. Her group conducted an experiment to test how the speed of a reaction would change at different temperatures. Below are the data table and data graph constructed by Karla and her group during the experiment.

Background Research:

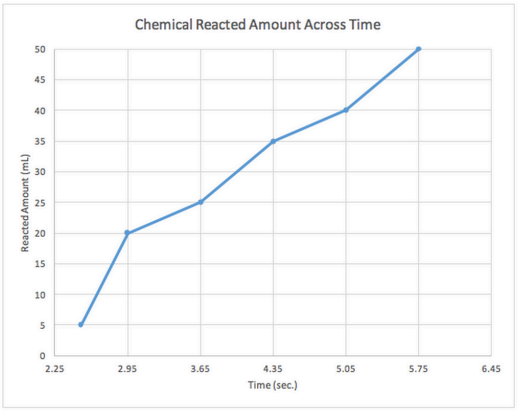
There are different factors that can affect how long it takes a chemical reaction to occur, such as temperature. Sometimes, an increase in temperature will cause the chemical reaction to occur faster. This is because of the additional energy added to the reaction. On the other hand, temperatures that are too hot may stop the chemical reaction. This is because the high temperatures could destroy some of the chemicals needed for the reaction to occur.



Hypothesis: The rate of the chemical reaction will increase as the temperature increases.

Use what you've learned about the background research and data graph to complete the following activity.

Analyze the data shown



Then use the background research to select all statements that provided a valid explanation for the relationship shown.

A	There is a steady increase in the amount of chemical that reacts as the reaction continues.
B	There is a steady increase in the rate up to a certain time, and then the amount that is reacted begins to decrease.
C	There is a steady decrease in the rate of the chemical reaction because the temperature destroyed chemicals needed.
D	There is an increase in the amount of chemical that is reacted as the reaction takes place and continues across time.
E	There was an increase in reaction and then a decrease in reaction to match the rate of time.

5. Summary

Great job! After all of the various steps of the scientific method have been completed and just prior to sharing the results, scientists finally have the opportunity to provide an explanation of why they believe the data showed a particular relationship between the variables. This is in

the form of an inference. This means that this explanation must be tied to the background data and evidence gathered during the investigation.

Now that you have completed the lesson, take some time to review the material and prepare for your lesson assessment. If you need more materials to review, click on the Reteach icon. If you are ready for your quiz, click on the assessment button. Good luck!