Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and non-linear association.

DETAILED LESSON PLAN: CHOLERA OUTBREAK!

What are the data showing?

Scatter plots are useful for displaying exact data, showing patterns in that data and for determining the correlation between two variables. In *Cholera Outbreak!*, Dr. John Snow and his sister, Annabelle, are distraught over the outbreak of cholera in London and feel the people are not getting adequate help from public offices. Dr. Snow believes the current theory of cholera being spread through the air is incorrect and has begun his own research to try to identify the true source. The data provided are the doctor's six scatter plots, each showing the number of cholera deaths in a home in relation to the distance of the home from the local water well.

Lesson Plan Overview

Lesson Length: 4 Days

Prerequisite Standards

- 6.NS.C.8

Vocabulary

- **Linear association:** When the data in a scatter plot (or graph) form a linear pattern; indicates that a change in one variable causes a change in another variable at a constant rate.
- **Negative association:** When the data in a scatter plot (or graph) form a decreasing pattern from left to right; indicates that an increase in one variable results in a decrease in another variable.
- **Non-linear association:** The ratio of change between two variables is not constant.
- **Outlier:** A data point that is much smaller or much larger than all other values in a data set.
- **Positive association:** When the data in a scatter plot (or graph) form an increasing pattern from left to right; indicates that an increase in one variable results in a increase in another variable.
- **Scatter plot:** A graph that displays a set of data as a collection of individual points; often used to determine what type of relationship exists (if any) between two variables.

Vocabulary Protocols:

- In your math classroom, make a Word Wall to hang and refer to vocabulary words throughout the lesson. As a whole-class exercise, create a visual representation and definition once students have had time to use their new words throughout a lesson.
- In the *Practice Printable*, remind students that key vocabulary words are highlighted. Definitions are available at the upper right in their student account.
- In the *Student Reflection*, the rubric lists the key vocabulary words for the lesson. Students are required to use these vocabulary words to explain, in narrative form, the math experienced in this lesson. During "Gallery Walks," vocabulary can be a focus of the "I Wonder..., I Notice..." protocol.

Applying Standards for Mathematical Practice

SMP 3 **Construct viable arguments and critique the reasoning of others.***

This is one of Jo Boaler's favorite lessons for teaching students the importance of data science. It is also a great lesson to spend extra time after the *Immersion* video to discuss how students are seeing the problem. Teachers apply Jo Boaler's tip and encourage students to ask one another: *How do you see this problem? How do you think about it?*, followed by students re-stating each other's reasoning in different ways. In *Data & Computation* and *Resolution*, students are encouraged to consider other students' points of view and interpretations, as they make sense of the various scatter plots and identify possible patterns

Cont'd concerning the cholera outbreak in London using the "Quick Write" protocol. Students are prompted to come to an agreement as a small group, justifying their thinking through making plausible arguments supported by the data. Each group presents their ideas, with the class asking clarifying questions and drawing conclusions to solve the problem together.

Mathematical Practice Tip from Jo Boaler: SMP 3

Mathematical communication between students both requires and creates higher understanding. When students make sense of each other's ideas they are given access to important understanding.

Sometimes parents and others say to me – my child can find the answer, why do they need to explain it? My answer to this is – when students explain mathematical thinking they are reasoning, and reasoning is one of the most important parts of mathematics – in some ways, it is what mathematics is. When mathematicians prove ideas they do so through reasoning, making connections between statements and ideas. Employers do not want people who can find answers (computers will do this), they want people who can reason, and explain to others. Mathematical communication has also been found to unlock students' understanding and bring about more equitable outcomes – for girls and students of color.

This is the essence of the mathematical practice of constructing viable arguments and critiquing the reasoning of others. In our research, we found that when we, as instructors, value different ideas students share in whole class settings, students start to value the ideas of others as we did. We also found that the language in prompts to students matters. 'Is this a reasonable answer?' encourages students to answer in a yes/no format, while 'What helps you determine if this is a reasonable answer?' leads students to explain their thinking.

Here are some ideas to promote SMP3 reasoning:

1. Pay attention to the ways interact in groups – encourage respect among students and spend time setting up careful classroom norms (see Boaler, 2019).
2. Talk to students about the importance of different ideas and ways of approaching problems.
3. Prompt students to start group work by going around the group and asking each other – *How do you see this problem? How do you think about it?*
4. Ask students to re-state each other's reasoning in different ways.
5. Have students explain their assumptions by prompting them with: *What must we assume to solve this problem?*
6. Ask students to justify their method with visuals, words, logic and data.
7. Encourage students to help others, and to support other students by asking rich questions instead of telling answers or leading through the problem.

Video Highlight: An example of students working well together in a group. (Run time: 3 min, 33 sec)
www.youcubed.org/resources/an-example-of-good-groupwork/

Cluster Connection

Cluster Heading: Investigate patterns of association in bivariate data.

- **Direct Connection:** In *Cholera Outbreak!*, students investigate patterns of association in multiple scatter plots and interpret those associations in the context of finding the source of cholera in London.
- **Cross-Cluster Connection:** This activity connects to 8.SP and 8.F as students will use their knowledge of linear and non-linear functions when describing patterns in scatter plots.

Common Misconceptions

- Some students may not understand that there are two directions in which a variable can "move." It may be helpful to have students verbalize how variable 1 changes in relation to variable 2, and vice versa.

Supporting Diverse Learners

Accommodations, Modifications and Extensions for English Learners (EL) and Special Populations

These supports may be appropriate for all students. Accommodations, modifications, and extensions are provided by curriculum component. Please consider additional supports where you find them appropriate for your students.

Note: Strategies contained in this section are appropriate for English Learners and students who are receiving services under the Federal Individuals with Disabilities Education Act (IDEA), Section 504 of the Rehabilitation Act of 1973, and state laws governing Talented and Gifted education.

Component	Accommodations/Modifications	Extensions
Test Trainer Pro	*Test Trainer Pro* automatically adapts to student ability level as students move through questions. Instruct students to work in a lower grade level or Core Skills (Grades 1-4) as needed.	*Test Trainer Pro* automatically adapts to student ability level as students move through questions. Instruct students to work in a higher grade level or Algebra I as needed.
The Math Simulator Immersion	Access Closed Caption and Spanish Subtitles within the video. Reinforce vocabulary in action: • *Cholera*: an infectious and often fatal disease of the small intestine. • *Outbreak*: the sudden start of something unpleasant, like war or disease. • *Epidemic*: a widespread occurrence of an infectious disease in a community. Ask students to summarize what was presented in the video. Replay if necessary.	
The Math Simulator Data & Computation	Provide sentence starters: *The _____ Street Well has a total of ____ deaths because _____.* *The _____ Street Well's deaths are (close to/far from) the well. This means that _____.* *I think the cause of the deaths is _____.*	
The Math Simulator Resolution	Access Closed Caption and Spanish Subtitles within the video. Consider summarizing the video after viewing it as it might be hard for some students to understand. *(This is especially important with EL students.)*	
Simulation Trainer	Pair students to allow for peer teaching and support.	Have more proficient students on this skill coach less successful students.

Component	Accommodations/Modifications	Extensions
Practice Printable	Upon completion of the first page (Procedure #1), consider following the *Exit Ticket Differentiation Plan*. Reinforce lesson vocabulary and ensure students understand the meaning and function of each word. Provide students with a pre-labeled graph for problem #2a.	Upon completion of the first page (Procedure #1), consider following the *Exit Ticket Differentiation Plan*.
Clicker Quiz	Have more proficient students on this skill coach less successful students.	Have more proficient students on this skill coach less successful students.
Student Reflection	Pair students to allow for peer teaching and support. Consider allowing EL students to write the narrative in their native language, then use a digital translator to help them transcribe it into English.	Have more proficient students on this skill coach less successful students.

Applying Mathematical Language Routines (MLRs)

While MLRs apply to all students, they are particularly beneficial for EL and other special populations. A full description of the MLRs is available in the Teacher Guide with a rationale for their use.

MLR 8

Discussion Supports

During *Immersion*, students engage in Think-Pair-Share, where they share their notes about what information they need to solve the Immersion problem on the whiteboard with the class.

Suggestion: Re-voice student ideas by turning them into clarifying questions, applying appropriate language and involving more students.

Instruction at a Glance


Gladys Graham


Kevin Simpson

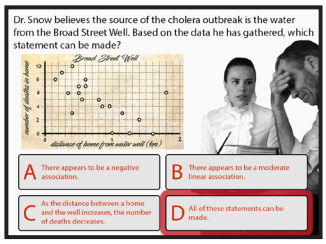

Megan LeBleu

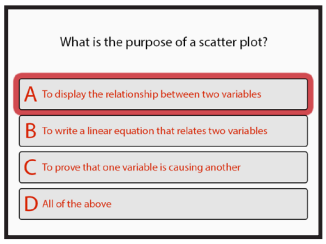
Gladys: Constructing a scatter plot is much like constructing the graph of a linear function; the data is just less predictable.

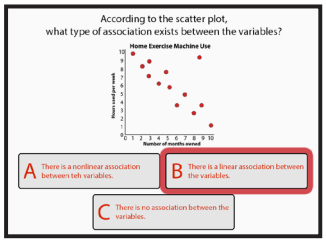
Kevin: Describing bivariate data in a scatter plot is very similar to describing univariate data in a line plot or histogram (Grade 6 & 7). With bivariate data, we are looking to see if there exists a relationship between the two variables.

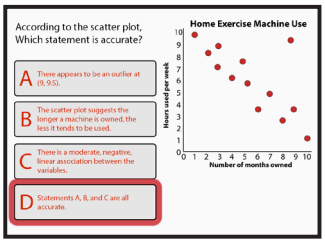
Megan: Help students understand *correlation* by giving them a few examples of variables with a high correlation (caloric intake, weight) and a few examples of variables with no correlation (shoe size, GPA). Have small groups come up with several examples of each on their own to share out.

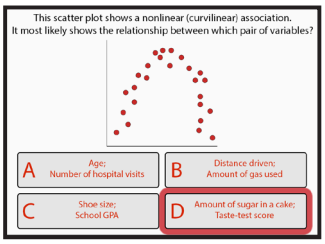
Clicker Quiz

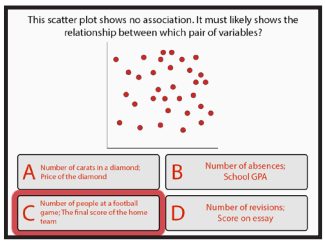












Practice Printable

Full-sized Answer Key available in printed Teacher's Guide

Name _____ Date _____ Period _____

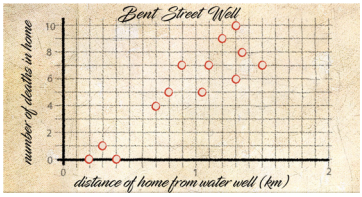
CHOLERA OUTBREAK!

What are the data showing?

After having identified the Broad Street water well as a very likely source of the cholera, Dr. John Snow continues to collect data of various water wells. He wants to pinpoint all of the affected areas and inform as many people as possible.

He has recently gathered data from the Bent Street Well. Complete the scatter plot using this new data.

Distance of home from water well (km)	0.9	1.2	0.4	1.3	0.2	0.7	1.5	1.05	0.3	1.35	1.1	0.8	1.3
Number of deaths in the home	7	9	0	6	0	4	7	5	1	8	7	5	10



8.SP.A.1
About this standard
Construct and interpret scatter plots for bi-variate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and non-linear association.

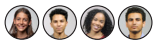
What are the data showing?

The data show a positive linear association, meaning that the further away homes are from the Bent Street Well, the more cholera deaths there are. This means that the Bent Street Well is not a likely source of cholera.

Name _____ Date _____ Period _____

APPLYING THE STANDARD

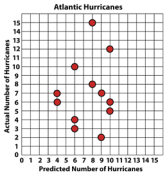
How might this standard appear on a test?


CHECK OUT MY WORKED EXAMPLE #1AB

1) Every year the NOAA releases hurricane season predictions for the Atlantic Basin, which includes the Atlantic Ocean, Caribbean Sea and the Gulf of Mexico. The table shows data for both the predicted and actual number of hurricanes from 2005 to 2016.

Atlantic Hurricanes		
Year	Predicted number of hurricanes	Actual number of hurricanes
2005	8	15
2006	10	5
2007	10	6
2008	8	8
2009	6	3
2010	10	12
2011	9	7
2012	6	10
2013	9	2
2014	4	6
2015	6	4
2016	4	7

a) Create a scatter plot on the graph, using the hurricane data in the table.



b) Where does the data appear to cluster?
The data clusters between 4 and 10 hurricanes on both axes.

c) Does there appear to be an outlier?
(YES) NO
If YES, where? (8, 15)

d) Are hurricane season predictions accurate? Explain your reasoning.

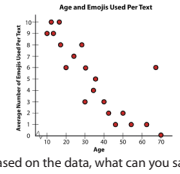
Hurricane season predictions aren't very accurate. If they were accurate, the data should form more of a line, with the predicted number closer to the actual number.

2) A survey group conducted a study to determine if there is an association between the age of a person and the average number of emojis used per text. The survey results are below.

Age and Emojis Used Per Text

Age	15	28	36	10	62	47	23	14	16	20	40	33	50	42	30	12	30	68	70	54
Average Number of Emojis Used Per Text	10	8	5	9	1	1	7	9	8	6	3	4	2	2	6	10	3	6	0	1

a) Create a scatter plot using the data in the table. Scatter plots may vary.



b) What type of association do the two variables seem to have?
NO ASSOCIATION
POSITIVE LINEAR ASSOCIATION
(NEGATIVE LINEAR ASSOCIATION)
NON-LINEAR ASSOCIATION

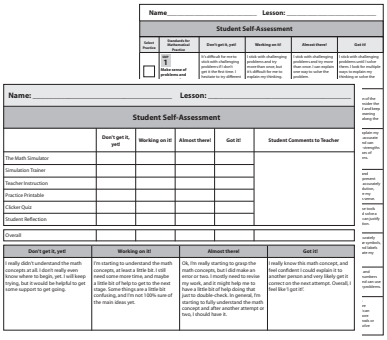
c) Does there appear to be an outlier?
(YES) NO
If YES, where? (68, 6)

d) Based on the data, what can you say about age and the number of emojis used per text?

The data shows that as age increases, the number of emojis used per text decreases.

Student Self-Assessment

Student Self-Assessments are an excellent way for teachers to gauge student learning. In combination with qualitative and quantitative data from the assignments, teachers can form a clear picture of student needs and follow-up appropriately. These self-assessments, if completed by students throughout a lesson, not only provide the teacher with useful information, but also improve student self-monitoring of learning.



Materials

- *Student Self-Assessment*
- Pencil

Standards Assessed:

- 8.SP.A.1
- SMP 3 (*The Math Simulator*)

Recommendations for Use:

Mathematical Standard

1. Distribute the *Student Self-Assessment* at the beginning of the lesson and fill in Name and Lesson title.
2. After each lesson component (*The Math Simulator, Simulation Trainer, Teacher Instruction, Practice Printable, Clicker Quiz, Student Reflection, Overall*), give students the opportunity to reflect on their perceived proficiency and knowledge of the content.
3. Ask students to mark their perceived proficiency or knowledge of the content, according to the scale provided (*Don't get it, yet!, Working on it!, Almost there!, Got it!*).
4. Students may then write any additional comments about their learning in the space provided.

Standards for Mathematical Practice

1. After students have completed a component that utilizes a specified SMP (as indicated above), have students mark the column on the SMP side of the *Student Self-Assessment*, to indicate the Standards for Mathematical Practice emphasized in that component.
2. Ask students to read through the various descriptions for that particular SMP and then mark the description that best describes their degree of use of the practice.
3. Repeat for other SMPs used in other lesson components.

Recommendations for Follow-Up:

Don't get it, yet!

Students in this learning phase require personal tutoring.

Partner with a classmate who rated themselves in the **Got it!** category. Review with your partner:

8.SP.A.1 Cholera Outbreak! Math Simulator

- Watch the *Immersion* video, and explain the story and the question.
- Review the class WorkPads, and discuss strategies used to solve the problem.
- Watch the *Resolution* video, and revise your work.

Working on it!

Students in this learning phase need focus in conceptual work.

Create a personal visual glossary for lesson vocabulary.

8.SP.A.1 Vocabulary Words:

Linear association
Negative association
Non-linear association
Outlier
Positive association
Scatter plot

- Look up each word in the student glossary.
- Read the definition and think about its meaning.
- Draw a picture that illustrates the meaning.

Almost there!

Students in this learning phase need practice with procedures.

Review the *Worked Example* video in the *Practice Printable* assignment and the written *Example Problem* in the *Student Workbook*:

8.SP.A.1 Cholera Outbreak! Worked Example

Compare your thinking to the video and the written solution.

- Identify any places where you have made mistakes.
- Correct any mistakes you have made on the *Practice Printable*.

Got it!

Students in this learning phase can reinforce their learning by teaching others.

Partner with a classmate who rated themselves in the **Don't get it yet!** category. Review with your partner:

8.SP.A.1 Cholera Outbreak! Math Simulator

- Watch the *Immersion* video, and ask them to explain the story and the question.
- Review the class WorkPads, and discuss strategies used to solve the problem.
- Watch the *Resolution* video, and have your partner revise their work.

Test Trainer Pro

Allow 7 to 10 minutes

As a warm-up, tell students to log into their account and access *Test Trainer Pro*. Specify the domain in which you would like students to work (preferably a different one than the prior day) and also the length of time you wish students to work (not a number of items). It is important to remind students to work out the math using paper and pencil when necessary and to look at their feedback.

The Math Simulator™

Allow 45 minutes

1 Immersion

Materials

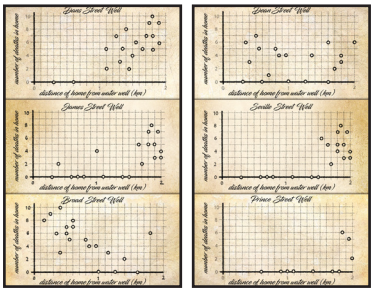
- *Cholera Outbreak! Immersion* video
- Chart paper/Interactive whiteboard

Procedure

1. Play the *Immersion* video to the whole class.
2. Restate the question and keep it visible: *What are the data showing?*
3. Whole class, ask students:
    - *What do we need to know?*
    - *Does anyone have any ideas about what could be causing the cholera outbreak in London?*
    - *How do you see this problem? How do you think about it?*

    As students form their ideas, have other students re-state each other's reasoning in different ways.

2 Data & Computation



Materials

- Copies of *Cholera Outbreak! Data Artifact*, one per student

Procedure

1. Divide your classroom into six groups and distribute the *Data Artifact* to each student.
2. Assign each group table one of the water wells from the *Data Artifact*.
3. Prompt student groups to use the **Quick Write** protocol to form logical statements about what they are seeing in the *Data Artifact* about the well they are assigned. For example, "The James Street Well has *x* total deaths because..." Encourage student groups to work together to construct plausible arguments supported by what the data are showing.
4. Have each group stand up and read their logical statements followed by their conclusion about the well, related to the *Immersion* video, while other student groups ask clarifying questions.
5. Facilitate a whole-class discussion to debrief what students know about each well to solve the problem together, asking: *Where do you think the cholera is coming from?*

Quick Write

Provide students with a unique prompt, such as: "I believe that the store owner should...", or "The person on Mars should make the decision to..." and include "because..." with blank space for students to complete.

3 Resolution

Materials

- *Cholera Outbreak! Resolution* video

Procedure

1. Play *Resolution* video to the whole class, and have the students compare their solutions as they watch.
2. Continue, whole-class, to summarize where the cholera is coming from (with supporting evidence from the data) in a one sentence argument statement.

Answer:
The data ultimately show that the Broad Street water well is a likely source of the cholera because the scatter plot shows that as the distance a home is from the well increases, the number of cholera deaths increases.

Student Self-Assessment

- Refer to the instructions for the *Studenf Self-Assessment* (on a prior page of this lesson plan).
- Allow students time to assess their level of knowledge after having completed this component.
- Collect the self-assessment from students, or have them keep it for later components.

Test Trainer Pro

Allow 7 to 10 minutes

As a warm-up, tell students to log into their account and access *Test Trainer Pro*. Specify the domain in which you would like students to work (preferably a different one than the prior day) and also the length of time you wish students to work (not a number of items). It is important to remind students to work out the math using paper and pencil when necessary and to look at their feedback.

The Math Simulator™
Simulation Trainer

Allow 25 to 35 minutes

Materials

- *Cholera Outbreak! Simulation Trainer*
- Student Devices
- Paper and Pencil
- Student Headphones

Procedure

1. Assign the *Simulation Trainer* to all students.
2. Tell students to navigate to the *Simulation Trainer* assignment.
3. Have students work individually to start.
4. Consider using varied protocols that include peer teaching.
5. Use *Progress Monitoring* on the *Teacher Dashboard* to determine which students are having difficulty. Provide individual help when necessary.

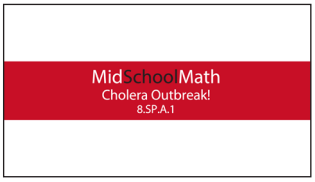
Student Self-Assessment

- Refer to the instructions for the *Studenf Self-Assessment* (on a prior page of this lesson plan).
- Allow students time to assess their level of knowledge after having completed this component.
- Collect the self-assessment from students, or have them keep it for later components.

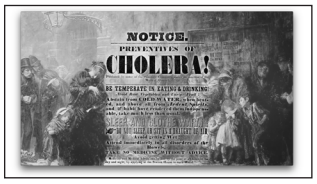
Teacher Instruction

Allow 10 to 15 minutes

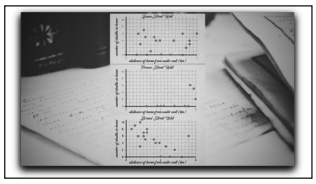
Consider this sample lecture to accompany the slide deck in the *Teacher Instruction* component. You may deliver the slide deck yourself, watch the video as a class, or assign the video to student devices. Alternatively, you may create and deliver your own concise, brief lecture using any method you see fit.



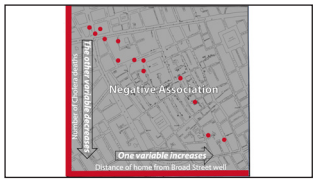
We're going to take a deeper look at the math we learned in *Cholera Outbreak!*.



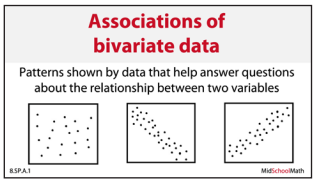
In *Cholera Outbreak!*, the people of London are suffering and dying because of cholera. Dr. John Snow is trying to figure out how the deadly disease is being spread.



Dr. Snow and his sister begin to look at data he has collected based on a theory. They observe scatter plots showing data from six water wells, relating the distance a home is to that well and the number of cholera deaths that have occurred in that home. The associations shown by the data tell Dr. Snow whether there is a relationship between the distance homes are from a well and the number of cholera deaths that occur. Dr. Snow finally sees an association that tells him something interesting.

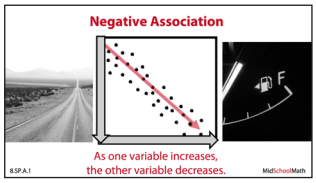


The data collected from the Broad Street Well was put into a scatter plot and an interesting pattern occurred. The data showed a pattern of going down from left to right, which is a negative association. It told Dr. Snow that as home distance from the Broad Street Well increased, the number of deaths usually decreased. Or, conversely, as home distance from the well decreased, the number of deaths increased, meaning that homes closer to the well have more deaths! This supported his theory that the source of the cholera was the water coming the Broad Street well.

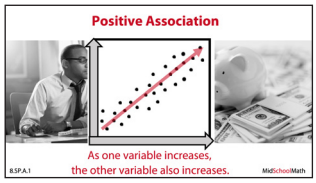


We just mentioned the word "associations." What are associations of bivariate data?

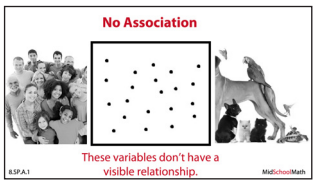
Bivariate data, remember, is data representing two variables and is frequently displayed in scatter plots, like the ones we see here. Associations are the patterns that we can see (or sometimes not see) when analyzing the data. They help us answer questions about whether two variables are related to one another in some way, like Dr. Snow's question about whether there was a relationship between cholera deaths and the water from the Broad Street well.



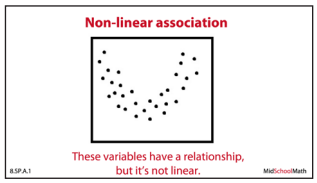
Let's look at another negative association. Here we have two variables, the distance driven down a highway and the amount of gas in the tank. What question might someone be thinking about here? This one might be obvious. "Is there a relationship between the number of miles someone drives and the amount of gas in their gas tank?"
This data will vary from car to car, from person to person but the general trend of the data will be a negative trend, which means this data has a negative association. As distance driven increases, the amount of gas in the tank decreases.



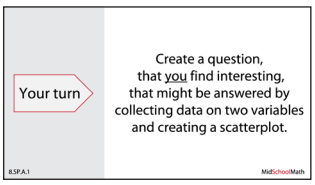
Here we have two other variables. On the left, we have a man that seems to be working, and on the right, we see money. If we collected data with these two variables, what question might we be trying to answer? *[Pause for student responses.]*
The question might be "Is there a relationship between the number of hours a person works and the amount of money they have?" What type of relationship or association might these two variables have? *[Pause for student responses.]*
This data will vary from person from person, and from job to job, but we would expect the general trend of the data to be positive, which means this data has a positive association. As the hours the man works increases, the amount of money he earns increases.



What about these two variables? On the left, we have a group of all types of people. We see men, women and children, both younger and older and from many different races. On the right, we have all different types of pets.
What question might we answer if we collected data on these two variables? *[Pause for student responses. There could be varied interpretations of what the images are representing.]*
Let's say we are collecting data on the age of people and the number of pets they have.
What type of relationship or association might these two variables have? *[Pause for student responses. There could be varied interpretations of what the images are representing.]*
Depending on how we interpret these two variables, the type of association or relationship we find between them might differ. If the data collected looked like this, with no predictable trend or pattern, we would say that these two variables have no association, meaning the age of a person doesn't really affect the number of pets they own.



There is another type of association that we'll briefly mention. We can clearly see a pattern in the data shown here, but the data doesn't consistently go up or down in any one direction. So we can say this data has a non-linear association.



Now it's your turn.

Note: Feel free to modify this part to suit your needs. You may even want to change this entirely to another activity or question.

Student Self-Assessment

- Refer to the instructions for the *Studenf Self-Assessment* (on a prior page of this lesson plan).
- Allow students time to assess their level of knowledge after having completed this component.
- Collect the self-assessment from students, or have them keep it for later components.

Test Trainer Pro

Allow 7 to 10 minutes

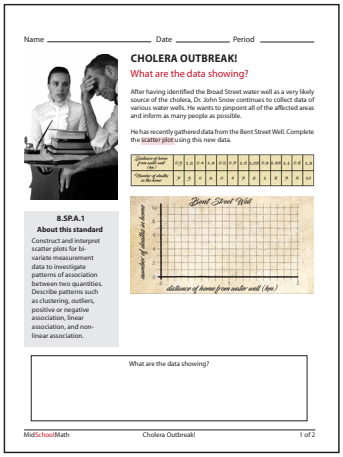
As a warm-up, tell students to log into their account and access *Test Trainer Pro*. Specify the domain in which you would like students to work (preferably a different one than the prior day) and also the length of time you wish students to work (not a number of items). It is important to remind students to work out the math using paper and pencil when necessary and to look at their feedback.

Practice Printable

Allow 35 minutes

Materials

- Copies of *Cholera Outbreak! Practice Printable*, 1 per student


Name _____ Date _____ Period _____

CHOLERA OUTBREAK!

What are the data showing?

After having identified the Broad Street water well as a very likely source of the cholera, Dr. John Snow continues to collect data of various water wells. He wants to pinpoint all of the affected areas and inform as many people as possible.

He has recently gathered data from the Bent Street Well. Complete the scatter plot using this new data.

8.SP.A.1
About this standard
Construct and interpret scatter plots for bi-variate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and non-linear association.

What are the data showing?

MidSchoolMath Cholera Outbreak! 1 of 2

Procedure

1. Distribute copies of the *Practice Printable*. Have students work through the first page.
2. Self-Rating: Ask students to rate their personal understanding of the problem on a scale of 1 to 3.
   1 = I need more help
   2 = I need more time, yet mostly understand
   3 = I've got this!
   Have students put the number on their *Practice Printable*.
3. Have students sort themselves based on the student self-rating and professional teacher judgment of accuracy of the response. This sorting can be used for grouping students for differentiation of instruction.
4. Implement the **Practice Printable Differentiation Plan** (see below) as students finish the *Practice Printable*.
5. Collect completed *Practice Printable*.

DON'T FORGET TO ASSIGN MY WORKED EXAMPLE!

Student Self-Assessment

- Refer to the instructions for the *Studenf Self-Assessment* (on a prior page of this lesson plan).
- Allow students time to assess their level of knowledge after having completed this component.
- Collect the self-assessment from students, or have them keep it for later components.

Practice Printable Differentiation Plan

Remediation

Meet with students who were unsuccessful on the f irst problemin a small group. Consider using whiteboards to work through problems on the *Practice Printable* together.

Practice

Students who completed the first problem but need more practice should spend the class period completing the *Practice Printable*. Encourage them to confirm strategies and solutions with each other. Any additional time remaining should be spent getting started on the *Student Reflection*.

Enrichment

Students who demonstrated confident mastery on the first problem can finish the *Practice Printable* and spend the remaining time getting started on the *Student Reflection* or completing the following:

- Continue exploring scatter plots of quantitative variables through real-life application: https://whyy.pbslearningmedia.org/resource/bb54bbbf-d5b3-471d-a24c-2e2181792d34/scatterplots-against-all-odds-unit-10
- Discover how correlation can be used in real-life to influence scientific studies: https://whyy.pbslearningmedia.org/resource/73c11f43-0065-4b3d-9926-b44cdff6257a/correlation-against-all-odds-unit-12

Student Reflection

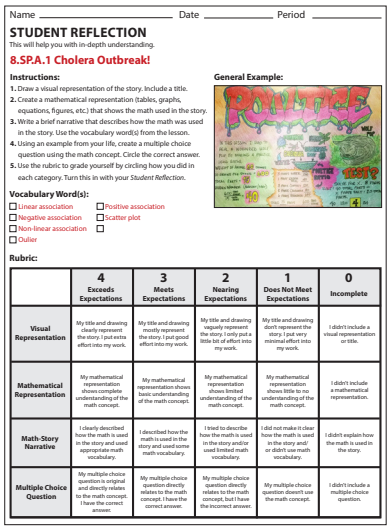
Allow 10 minutes (optional)

Materials

- Copies of *Student Reflection* rubric, 1 per student
- White Paper
- Colored Pencils

Procedure

1. Available in the *Student Reflection* lesson on Teacher Dashboard, print and distribute the rubric. Discuss requirements with students.
2. Distribute white paper and colored pencils to students.
3. Have students begin the *Student Reflection* by sketching a draft. They will have additional time the following day to complete it.



Name _____ Date _____ Period _____

STUDENT REFLECTION

This will help you with in-depth understanding.

8.SP.A.1 Cholera Outbreak!

Instructions:

1. Draw a visual representation of the story. Include a title.
2. Create a mathematical representation (tables, graphs, equations, figures, etc.) that shows the math used in the story.
3. Write a brief narrative that describes how the math was used in the story. Use the vocabulary word(s) from the lesson..
4. Using an example from your life, create a multiple choice question using the math concept. Circle the correct answer.
5. Use the rubric to grade yourself by circling how you did in each category. Turn this in with your *Student Reflection*.

General Example:

Vocabulary Word(s):

☐ Linear association ☐ Positive association
☐ Negative association ☐ Scatter plot
☐ Non-linear association ☐
☐ Outlier

Rubric:

	4 Exceeds Expectations	3 Meets Expectations	2 Nearing Expectations	1 Does Not Meet Expectations	0 Incomplete
Visual Representation	My title and drawing clearly represent the story. I put extra effort into my work.	My title and drawing mostly represent the story. I put good effort into my work.	My title and drawing vaguely represent the story. I only put a little bit of effort into my work.	My title and drawing don't represent the story. I put very minimal effort into my work.	I didn't include a visual representation or title.
Mathematical Representation	My mathematical representation shows complete understanding of the math concept.	My mathematical representation shows basic understanding of the math concept.	My mathematical representation shows limited understanding of the math concept.	My mathematical representation shows little to no understanding of the math concept.	I didn't include a mathematical representation.
Math-Story Narrative	I clearly described how the math is used in the story and used appropriate math vocabulary.	I described how the math is used in the story and used some math vocabulary.	I tried to describe how the math is used in the story and/or used limited math vocabulary.	I did not make it clear how the math is used in the story and/ or didn't use math vocabulary.	I didn't explain how the math is used in the story.
Multiple Choice Question	My multiple choice question is original and directly relates to the math concept. I have the correct answer.	My multiple choice question directly relates to the math concept. I have the correct answer.	My multiple choice question directly relates to the math concept, but I have the incorrect answer.	My multiple choice question doesn't use the math concept.	I didn't include a multiple choice question.

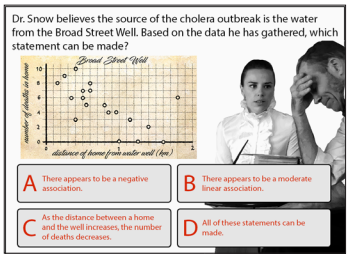
Test Trainer Pro

Allow 7 to 10 minutes

As a warm-up, tell students to log into their account and access *Test Trainer Pro*. Specify the domain in which you would like students to work (preferably a different one than the prior day) and also the length of time you wish students to work (not a number of items). It is important to remind students to work out the math using paper and pencil when necessary and to look at their feedback.

Clicker Quiz

Allow 30 minutes



Materials

- *Cholera Outbreak! Clicker Quiz*
- Student Devices
- Paper and Pencil

Procedure

1. Ask students to log into their account and access *Virtual Clicker*.
2. Open the *Clicker Quiz*, whole class.
3. Prompt students to enter the quiz code on their device.
4. Launch quiz.
5. For each question:
    a. Show question and give students time to work. Consider using various protocols (i.e., students work individually, work with a partner, or maybe they have to agree with an entire table).
    b. Click "Vote," and students will have 10 seconds to enter a response.
    c. Analyze class distribution. Decide whether more teaching is necessary, either a mini-lesson from you or by having students share strategies.
    d. Click ">" to advance to the next question.
    e. You may either then "Skip" the question or repeat steps a through e.

Student Self-Assessment

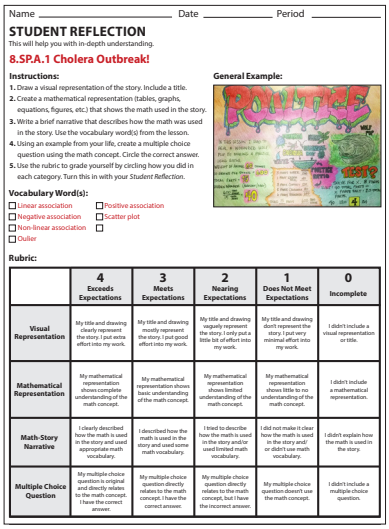
- Refer to the instructions for the *Studenf Self-Assessment* (on a prior page of this lesson plan).
- Allow students time to assess their level of knowledge after having completed this component.
- Collect the self-assessment from students, or have them keep it for later components.

Student Reflection

Allow 20 minutes (optional)

Materials

- *Student Reflections* from Day 3
- White Paper
- Colored Pencils
- Sticky Notes



Name _____ Date _____ Period _____

STUDENT REFLECTION

This will help you with in-depth understanding.

8.SP.A.1 Cholera Outbreak!

Instructions:

1. Draw a visual representation of the story. Include a title.
2. Create a mathematical representation (tables, graphs, equations, figures, etc.) that shows the math used in the story.
3. Write a brief narrative that describes how the math was used in the story. Use the vocabulary word(s) from the lesson.
4. Using an example from your life, create a multiple choice question using the math concept. Circle the correct answer.
5. Use the rubric to grade yourself by circling how you did in each category. Turn this in with your *Student Reflection*.

General Example:

Vocabulary Word(s):

- ☐ Linear association
- ☐ Positive association
- ☐ Negative association
- ☐ Scatter plot
- ☐ Non-linear association
- ☐
- ☐ Outlier

Rubric:

	4 Exceeds Expectations	3 Meets Expectations	2 Nearing Expectations	1 Does Not Meet Expectations	0 Incomplete
Visual Representation	My title and drawing clearly represent the story. I put extra effort into my work.	My title and drawing mostly represent the story. I put good effort into my work.	My title and drawing vaguely represent the story. I only put a little bit of effort into my work.	My title and drawing don't represent the story. I put very minimal effort into my work.	I didn't include a visual representation or title.
Mathematical Representation	My mathematical representation shows complete understanding of the math concept.	My mathematical representation shows basic understanding of the math concept.	My mathematical representation shows limited understanding of the math concept.	My mathematical representation shows little to no understanding of the math concept.	I didn't include a mathematical representation.
Math-Story Narrative	I clearly described how the math is used in the story and used appropriate math vocabulary.	I described how the math is used in the story and used some math vocabulary.	I tried to describe how the math is used in the story and/or used limited math vocabulary.	I did not make it clear how the math is used in the story and/ or didn't use math vocabulary.	I didn't explain how the math is used in the story.
Multiple Choice Question	My multiple choice question is original and directly relates to the math concept. I have the correct answer.	My multiple choice question directly relates to the math concept. I have the correct answer.	My multiple choice question directly relates to the math concept, but I have the incorrect answer.	My multiple choice question doesn't use the math concept.	I didn't include a multiple choice question.

Procedure

1. Students continue working and complete their *Student Reflections*.
2. Consider having a **Gallery Walk** when they are complete, using the **I Wonder…, I Notice…** protocol and sticky notes.

Gallery Walk (16-20 min)

Display student work (such as Student Reflections) on classroom walls. Assign groups with tasks focused on specific details (such as identifying different ways to solve a problem) and/or larger patterns (such as general misconceptions). Tell groups to walk around, complete their task (≈ 8-10 min), then prepare and report brief remarks to the class with their broader "a-ha" and "why" understandings (≈ 8-10 min).

I Wonder . . . , I Notice . . . (8-10 min)

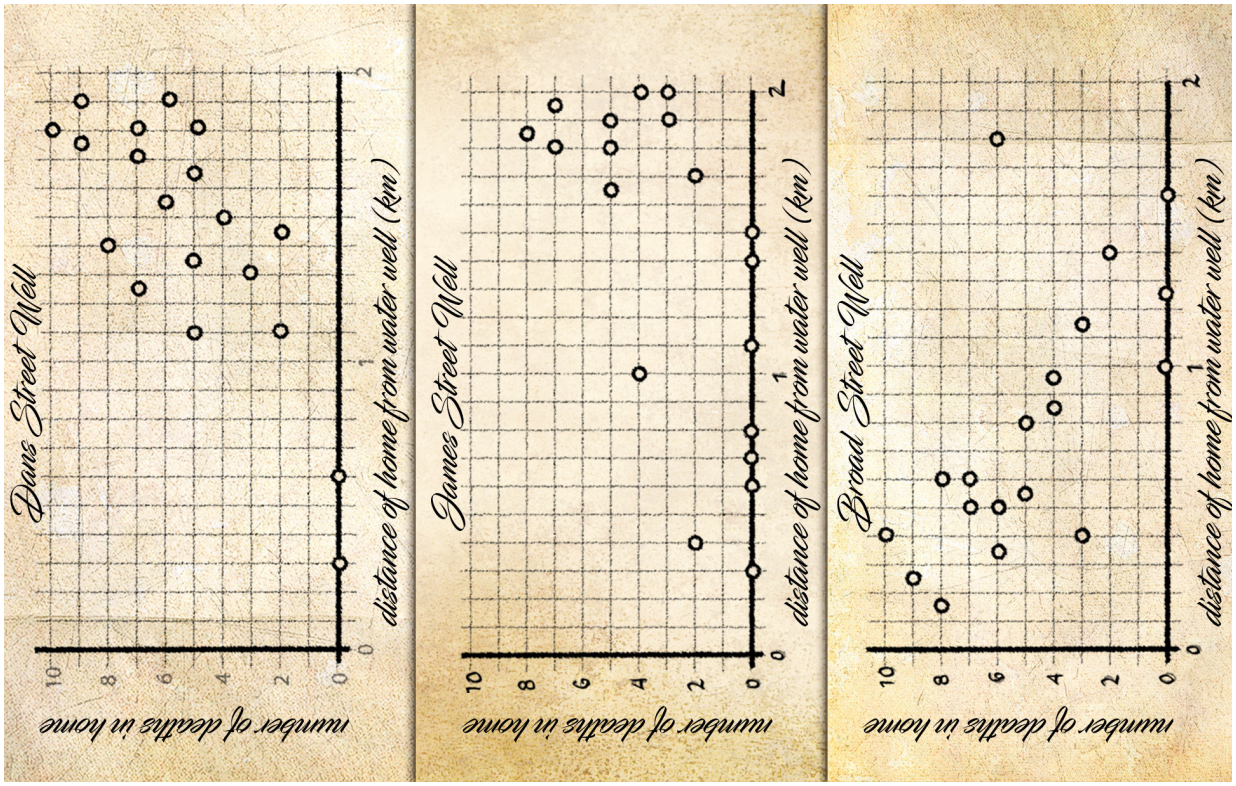
Following a completed whole-class assignment, set ground rules for peer critique, including being thoughtful, specific, helpful and joining in (≈ 1 min)! Choose a student to be "the originator" who is tasked to explain his or her approach and solution to a problem (≈ 2 min), while other students listen only. Then ask other students to ask "the originator" clarifying questions or comments that start with 'I wonder' and 'I notice' (≈ 5-6 min).

Student Self-Assessment

- Refer to the instructions for the *Studenf Self-Assessment* (on a prior page of this lesson plan).
- Allow students time to assess their level of knowledge after having completed this component.
- Collect the self-assessment from students, or have them keep it for later components.

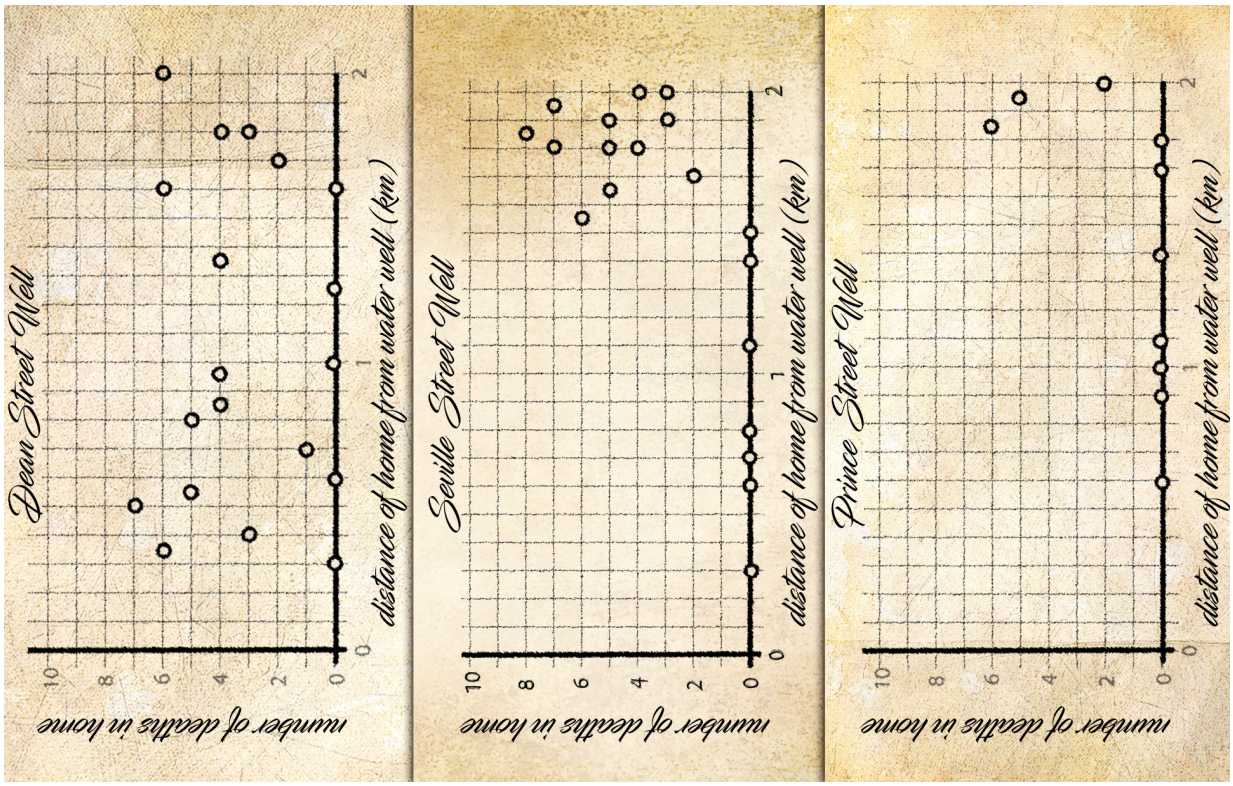
CHOLERA OUTBREAK!

Artifact 1



CHOLERA OUTBREAK!

Artifact 2



Name _____ Date _____ Period _____

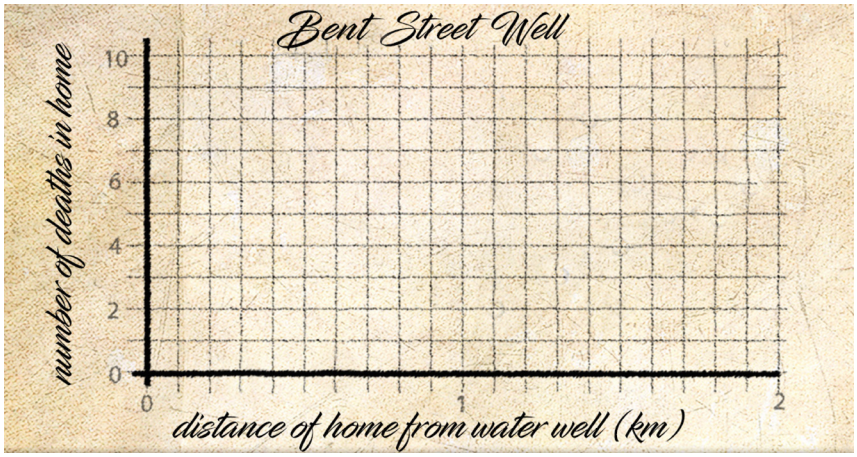
CHOLERA OUTBREAK!

What are the data showing?

After having identified the Broad Street water well as a very likely source of the cholera, Dr. John Snow continues to collect data of various water wells. He wants to pinpoint all of the affected areas and inform as many people as possible.

He has recently gathered data from the Bent Street Well. Complete the scatter plot using this new data.

Distance of home from water well (km)	0.9	1.2	0.4	1.3	0.2	0.7	1.5	1.05	0.3	1.35	1.1	0.8	1.3
Number of deaths in the home	7	9	0	6	0	4	7	5	1	8	7	5	10



8.SP.A.1

About this standard

Construct and interpret scatter plots for bi-variate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and non-linear association.

What are the data showing?

Name _____ Date _____ Period _____

APPLYING THE STANDARD

How might this standard appear on a test?

Check out my worked example #1AB

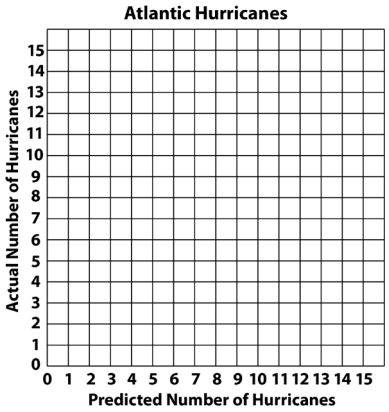
1) Every year the NOAA releases hurricane season predictions for the Atlantic Basin, which includes the Atlantic Ocean, Caribbean Sea and the Gulf of Mexico. The table shows data for both the predicted and actual number of hurricanes from 2005 to 2016.

Atlantic Hurricanes		
Year	Predicted number of hurricanes	Actual number of hurricanes
2005	8	15
2006	10	5
2007	10	6
2008	8	8
2009	6	3
2010	10	12
2011	9	7
2012	6	10
2013	9	2
2014	4	6
2015	6	4
2016	4	7

a) Create a scatter plot on the graph, using the hurricane data in the table.

b) Where does the data appear to cluster?

c) Does there appear to be an outlier?
YES NO
If YES, where? _____



d) Are hurricane season predictions accurate? Explain your reasoning.

2) A survey group conducted a study to determine if there is an association between the age of a person and the average number of emojis used per text. The survey results are below.

Age and Emojis Used Per Text

Age	15	28	36	10	62	47	23	14	16	20	40	33	50	42	30	12	30	68	70	54
Average Number of Emojis Used Per Text	10	8	5	9	1	1	7	9	8	6	3	4	2	2	6	10	3	6	0	1

a) Create a scatter plot using the data in the table.

b) What type of association do the two variables seem to have?

NO ASSOCIATION
POSITIVE LINEAR ASSOCIATION
NEGATIVE LINEAR ASSOCIATION
NON-LINEAR ASSOCIATION

c) Does there appear to be an outlier?
YES NO
If YES, where? _____

d) Based on the data, what can you say about age and the number of emojis used per text?

Name: _____ **Lesson:** _____

Student Self-Assessment

	Don't get it, yet!	Working on it!	Almost there!	Got it!	Student Comments to Teacher
The Math Simulator					
Simulation Trainer					
Teacher Instruction					
Practice Printable					
Clicker Quiz					
Student Reflection					

Overall					

Don't get it, yet!	Working on it!	Almost there!	Got it!
I really didn't understand the math concepts at all. I don't really even know where to begin, yet. I will keep trying, but it would be helpful to get some support to get going.	I'm starting to understand the math concepts, at least a little bit. I still need some more time, and maybe a little bit of help to get to the next stage. Some things are a little bit confusing, and I'm not 100% sure of the main ideas yet.	Ok, I'm really starting to grasp the math concepts, but I did make an error or two. I mostly need to revise my work, and it might help me to have a little bit of help doing that just to double-check. In general, I'm starting to fully understand the math concept and after another attempt or two, I should have it.	I really know this math concept, and feel confident I could explain it to another person and very likely get it correct on the next attempt. Overall, I feel like 'I got it!'.

Name_____ **Lesson:** _____

Student Self-Assessment

Select Practice	Standards for Mathematical Practice	Don't get it, yet!	Working on it!	Almost there!	Got it!
☐	SMP 1 **Make sense of problems and persevere in solving them.**	It's difficult for me to stick with challenging problems if I don't get it the first time. I hesitate to try different strategies.	I stick with challenging problems and try more than once, but it's difficult for me to explain my thinking.	I stick with challenging problems and try more than once. I can explain one way to solve the problem.	I stick with challenging problems until I solve them. I look for multiple ways to explain my thinking or solve the problem.
☐	SMP 2 **Reason abstractly and quantitatively.**	It's difficult for me to create a representation of the problem. I don't know how to apply math symbols to solve problems.	I can create a representation of the problem, but I often lose track of the units or the meaning of my results along the way.	I can create a representation of the problem, but I sometimes lose track of the units or the meaning of my results along the way.	I can create a representation of the problem. I consider the units involved and keep track of the meaning of my results along the way.
☐	SMP 3 **Construct viable arguments and critique the reasoning of others.**	It's difficult for me to explain my own thinking and to understand the thinking of others.	I sometimes explain my own thinking but without accurate vocabulary, and rarely understand the solutions of others.	I often explain my thinking with accurate vocabulary, and can sometimes identify strengths and weaknesses of others' solutions.	I frequently explain my thinking with accurate vocabulary, and can often identify strengths and weaknesses of others' solutions.
☐	SMP 4 **Model with mathematics.**	It's difficult for me to represent problems and to develop a structure to solve them.	I identify important quantities in problems but have difficulty representing their relationships.	I use models and symbols to represent problem, and can explain the solution.	I use models and symbols to represent problem, can accurately explain the solution, and make sure my answer makes sense.
☐	SMP 5 **Use appropriate tools strategically.**	It's difficult for me to know when and how to use tools to help me solve a problem.	I sometimes use tools to explore and solve a problem but it's difficult to justify my choice.	I often use tools to explore and solve a problem and can justify my tool selection.	I frequently use tools to explore and solve a problem and can justify my tool selection.
☐	SMP 6 **Attend to precision.**	My calculations are often inaccurate, and it's difficult for me to communicate my thinking.	My calculations are sometimes inaccurate, and my communication is not always clear.	I calculate accurately and mostly use symbols, vocabulary, and labels to communicate my thinking.	I calculate accurately and always use symbols, vocabulary, and labels to communicate my thinking.
☐	SMP 7 **Look for and make use of structure.**	It's difficult for me to see patterns and structures in numbers and figures.	I sometimes see patterns and structures in numbers and figures, and can sometimes use them to solve problems.	I often see patterns and structures in numbers and figures, and can often use them to solve problems.	I see patterns and structures in numbers and figures, and can use them to solve problems.
☐	SMP 8 **Look for and express regularity in repeated reasoning.**	It's difficult for me to notice repeated calculations, and rarely find shortcuts.	I sometimes notice when calculations are repeated and might be able to find shortcuts to solve problems.	I notice when calculations are repeated and can often find shortcuts to solve problems.	I notice when calculations are repeated and can always find more efficient methods or shortcuts to solve problems.