Plot a Lot of Dots

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Overview: This lesson allows students to visit web sites, view scatterplots of two-variable statistics, and determine whether a positive or negative correlation exists. Using the graphing capabilities of the STAT PLOT function on the TI-83 graphing calculator, students will enter, graph, and study the data concerning O-ring failure during the Challenger Disaster. The scatterplot will be analyzed for positive or negative correlations and safety implications.

Grade 7

Time Allotment:

Two 50-minute class periods

Subject Matter:

Mathematics, statistics

Learning Objectives:

Students will be able to:

- Collect data
- Determine the independent and dependent variables
- Use the graphing calculator to display data in a scatterplot
- Identify positive and negative correlations

Standards:

This lesson addresses Va. SOL Mathematics 7.20 and 7.21 available at www.pen.k12.va.us

Media Components:

Video: ***Math Vantage #13,*** Data How Do You Show It

Web sites:
http://www.seattlecentral.org/qelp/Data_MathTopics.html The Quantitative Environmental Learning Project (QELP) web site provides resources to integrate math and environmental science. Data sets are provided for classroom demonstrations and projects.
http://exploringdata.cqu.edu.au/ws_scatr.htm The Exploring Data web site provides curriculum support and materials for teachers of introductory statistics.

Materials:

Materials needed for the Introductory Activity and Culminating Activity:

- Computer with access to the Internet and large screen TV or projection device
- Overhead projector, blank overhead transparencies, transparency pens
- Transparency of a coordinate plane.
- TI-83 overhead graphing calculator and view screen
- Force sensor, din pin adapter, motion detector (Available from http://www.vernier.com)
- Calculator Based Laboratory (CBL) (Available from http://www.ti.com)
- STRETCH program for the graphing calculator loaded onto the overhead graphing calculator. (The program can be downloaded from http://www.ti.com/calc/docs/cblwb3.htm or downloaded from the disk that comes with Real World Math with the CBL System Brueningsen, Bower, Antinone, Brueningsen, Texas Instruments)
- One 4 to 6 inch rubber band
- Transparency of Handout-Scatterplots: The Challenger Disaster

For each pair of students

- TI-83 graphing calculator
- Handout -Scatterplots: The Challenger Disaster

Prep for Teachers

Prior to teaching this lesson, bookmark the sites listed above. Visit the web sites and familiarize yourself with the data that will be used in the investigations.
Make a transparency and student copies of the student handout, Scatterplots: The Challenger Disaster.
Cue the videotape to the beginning of the viewing segment. Familiarize yourself with the audio and visual cues used in the Learning Activity portion of the lesson.
Load the program "Stretch" onto your graphing calculator. Do the various graphing calculator activities found in the lesson.

Introductory Activity: Setting the Stage

1. Say, "Today we will be investigating the importance of looking at graphs of data. One thing that statisticians and scientists are always interested in is whether or not there is a linear pattern in the data. If a linear pattern exists, we can use the graph to make predictions and decisions. In our first activity, we will be using the motion detector and a force sensor to collect data about the amount of force that results when a rubber band is stretched. We want to analyze the relationship between the distance the rubber band is stretched and the exerted force."
2. To help students visualize the activity, hook the rubber band onto the force sensor and begin to stretch the rubber band back and forth.
3. Say, "Before we perform the activity, let's brainstorm and make some predictions as to what we expect will occur. What do you think the relationship will be between the distance the rubber band is stretched and the amount of force that is exerted?" (the greater the stretch the greater the force)
4. Say, "Now that we've decided that the more we stretch the rubber band the greater the force, we need to decide which variable will be the independent variable and represented on the x-axis. Think about which variable we will be controlling, the stretch or the force?" (stretch) Say, "Since we are controlling the stretch this will be the independent variable, or x. Therefore, the resulting variable or dependent variable will be the force and that will be represented on the y-axis."
5. Place the graph transparency on the overhead projector. Label the x-axis stretch (in feet) and the y-axis force (in pounds). Say, "We are labeling the x-axis stretch since it is the independent variable. It is called the independent variable because we are controlling the amount of stretch that occurs. We are labeling the y-axis force since it is the dependent variable. The force depends on the distance the rubber band is stretched."
6. Turn on the overhead graphing calculator. Press the PRGM key on the overhead graphing calculator, arrow down to the STRETCH program, press ENTER to select the program and ENTER to run the program. Follow the directions on the graphing calculator screen. These directions consist of using the unit-to-unit link cable to connect the CBL to the graphing calculator, hooking up the force sensor to the channel 1 port of the CBL and the motion detector to the sonic port, and turning on the CBL. The calculator will check to make sure all of the connections are correct and state that the status is O.K. Align the motion detector and force sensor about 3 feet apart on a table.

Attach a large rubber band (4 to 6 inches in length) to the force sensor. Continue to follow the directions on the graphing calculator screen. Once the data is collected the scatterplot will appear. (A diagram of the setup and the directions as displayed on the calculator screen are provided at the end of the lesson.)

7. Ask, "Can anyone give me the name of this type of graph?" (Scatterplot)
8. Ask, "What is the basic shape of the graph?" (a line)
9. Say, "Notice that the line is going up from left to right."
10. Ask, "What does the fact that this graph is going up from left to right tell us about the relationship between the amount of stretch and the resulting amount of force?" (The greater the stretch the greater the force)
11. Say, "When we see a linear pattern that is increasing from left to right, we call this a positive correlation. In other words, as the independent variable increases the dependent variable also increases."

Learning Activities

1. ***Provide the students with a Focus for Media Interaction,*** and say," Now that we have seen one example of a scatterplot, let's go to the internet and continue to investigate the graphs of data collected by scientists."
2. Go to the web site http://www.seattlecentral.org/qelp/Data_MathTopics.html
3. Click on DataSet#001 Puget Sound Butter Clams Length v. Width.
4. ***Focus:*** Say, "Notice the x-axis represents the width of the clam. This is the independent variable. The y-axis represents the length and is the dependent variable." Ask, "Visually, what tells us that a relation exists?" (The scatterplot forms a line.) Ask, "How would you describe the correlation, positive or negative?" (It's positive, since the line goes up.) Ask, "What does this positive correlation mean?" (As the width increases the length also increases.)
5. Say, "Let's investigate another set of data, this time about the Columbia River."
6. Go to the web site http://www.seattlecentral.org/qelp/Data_MathTopics.html or click "back".
7. Click on DataSet#011 Columbia River Velocity v. Depth.
8. ***Focus:*** Say, "Scientists selected a location on the Columbia River and measured the velocity of the water at different depths. This information is important in determining average velocity and river discharge, the volume of water flowing past in a given amount of time. Visually, what tells us that a relationship exists?" (We see a linear pattern.) Ask, "What does the x-axis or independent variable represent?" (depth) Ask, "What does the y-axis or dependent variable represent?" (velocity) Ask, "As the depth changes what happens to the velocity of the water?" (the greater the depth, the slower the velocity) Say," This is called a negative correlation. How does the graph indicate that this is a negative correlation?" (The line is going down from left to right.)
9. Insert the video, "Data How Do You Show It", into the VCR.
10. ***Provide the students with a Focus for Media Interaction,*** and say, "Let's look at some other examples. I want you to pay close attention to this video clip and identify the independent and dependent variables. Then, decide what kind of correlation this graph represents." START the Math Vantage #13 video directly after the box and

whiskers segment and the host says, "With a quick look at the box and whisker plots". PAUSE the video when Ellen appears wearing a track uniform and says, "I can see a positive correlation between how much I practice and how much I can lift." Say, "What two variables are we comparing in this segment?" (The number of practices and the amount of weight that can be lifted) Ask, "Which is the independent variable or the variable that Ellen can control?" (The number of practices) Ask, "Which is the dependent variable or the variable that depends on the other variable?" (The amount of weight that she can lift) Say, "What does Ellen mean when she says she can see a positive correlation?" (The more she practices the more she can lift) Say, "A positive correlation implies that as the independent variable increases so does the dependent variable. As the number of practices increase Ellen is able to lift more weight."

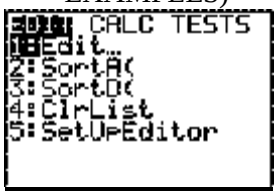
11. Say, "The Columbia River Velocity v. Depth was an example of a negative correlation. Can anyone think of another example of a negative correlation, where if the independent variable increases the dependent variable decreases?" (Allow students to brainstorm about possibilities. Some examples are the more calories you burn, the less you weigh or the further you drive the less gas you have in your car.)
12. ***Focus:*** Say, "Let's look at another situation and see if we can determine the independent and dependent variables and whether a correlation exists". RESUME. PAUSE the video after Ellen says, "Well, that all makes sense but what if we change our observations from weight lifting to the time it takes to run a certain distance?"
13. ***Focus:*** Ask, "What are the two variables in this scenario?" (The number of practices and the time it takes to run a certain distance) REWIND to the previous pause and REPLAY this segment if necessary. Ask, "In this situation, which is the independent variable and which is the dependent variable?" (The independent variable is the number of practices and dependent variable is the time it takes to run the given distance)
14. ***Focus:*** Ask, "What do you think this graph will look like? How will the axes be labeled and what general shape will the points have?" (The x-axis will be the number of practices and the y-axis will be the time to run the given distance, and the general shape will be a line with negative slope) Say, "Let's see if we are correct." RESUME. STOP when Ellen finishes the race. Ask, "Did we agree?" Compare student responses to the graph given.

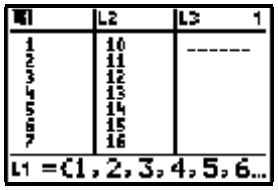
Culminating Activity

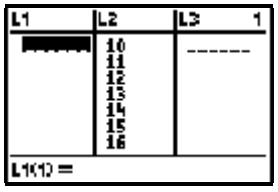
1. Say, "Now we are going to investigate the Challenger Disaster, use the graphing calculator to create our own scatterplot and see how a visual display of the data can be a powerful communication tool."
2. Hand out the Challenger Disaster worksheet and a TI-83 graphing calculator to each pair of students.
3. Say, "We will be studying the relationship between O-ring damage and ambient temperature. Before we begin let's read the summary provided for us." (Allow time for students to read the handout.)
4. Ask, " What caused the Challenger Disaster and why did the launch proceed? (The O-rings leaked during takeoff and the engineers failed to persuade NASA to cancel the launch.)

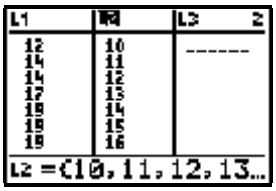
5. Say, “Before we create our scatterplot we need to decide which variable will be the independent variable and which will be the dependent variable. Ask yourself which is a more logical relationship to see if the O-ring damage depends on the temperature or whether the temperature depends on the O-ring damage.” Ask, “Which is more logical to you?” (The O-ring damage depends on the temperature.) Say, “Since it is more logical that the O-ring damage **depends** on the temperature, the O-ring damage is the **dependent** variable, y. The independent variable must be the temperature and will be represented by x.
6. Graphing Calculator Activity: If students have not had much experience with graphing calculators, have one pair of students use the overhead graphing calculator and view screen to demonstrate the process. Say, “Now we will enter the data into the graphing calculator. The temperature will be entered into List 1. To do this, on your calculator, press STAT and then ENTER. This allows us to edit the lists. To clear out old data from List 1, arrow up to the very top of the list until the cursor becomes a square instead of a rectangle and L1 is highlighted. Press CLEAR, then arrow down to the first line of L1. The list is now ready to receive the temperature data. Once you have completed L1, press the right arrow and you will be in L2. To clear out this list, arrow up to the very top of the list until the cursor becomes a square instead of a rectangle and L2 is highlighted. Press CLEAR, then arrow down to the first line of L2. The list is now ready to receive the O-ring damage data. Once each pair of students has the data in L1 and L2, instruct students to go to STAT PLOT (2nd Y=) and press ENTER twice to turn on plot 1. Set the type to scatterplot (the first icon). The X-list should be L1, the Y-list should be L2, and Frequency should be 1. Press ZOOM, 9:ZoomStat to view the scatterplot. Press TRACE and arrow right and left to see the individual points and their coordinates. Have students analyze what happens to the amount of O-ring damage as the temperature approaches 0° Celsius. (The amount of damage increases dramatically.) Have students determine if there is a correlation and if so, whether the correlation is positive (the line goes up from left to right) or negative (the line goes down from left to right). Have students discuss why this might be so. (There is a negative correlation. As the temperature warms up the O-rings are more flexible and seal properly; the amount of damage decreases.)

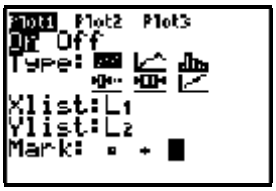
CALCULATOR SCREENS FOR THE CULMINATING ACTIVITY (DATA FOUND IN THE 2ND AND 3RD SCREENS ARE ONLY EXAMPLES)











7. NOTE: If you don¹t see your scatterplot, here are a couple of possible reasons why:
    - If your calculator says, ERR: DIM Mismatch, check L1 and L2 to see if you have the same number of elements in each list (you may not). Do this by pressing STAT and ENTER. Now check the lists for discrepancies.
    - The data could have been placed in lists other than L1 and L2. Press STAT, 5:SetUpEditor, ENTER. The home screen will display Done. Press STAT, ENTER and reenter the data in L1 and L2.
    - If nothing appears on your graph, you may not have turned Plot 1 on. Go to STAT PLOT (2^{nd} Y=), and then turn Plot 1 on. Now, hit GRAPH again.
8. Have students answer the following question and justify their response. Based on this graphic, what recommendation would you have made for a flight if the forecast was for below 0° Celsius?

Cross-Curricular Extensions

Science:
http://www.seattlecentral.org/qelp/Data_MathTopics.html
This web site offers numerous scatterplots, the data, and their related stories. Some of the topics include: water resources, ecology, energy, water pollution, air pollution, agriculture, planet earth, and solid waste.

English: Have students collect data and analyze the relationship between the number of hours spent watching TV and the number of hours spent reading.

Health:
http://exploringdata.cqu.edu.au/movies.htm
"Using a Scatterplot to Find a Friend" is a great introductory activity that helps students learn about scatterplots and correlation. Created by Peter Smith from Mechanicsburg High School in Pennsylvania, this activity asks students to rate the top ten movies of the past year and use a scatterplot to determine the students' compatibility.

Mathematics: http://trackstar.hprtec.org/
Track id: 42566
Interpreting and Displaying Data by Christine Plunk is a Trackstar unit about data analysis and discrete math. This unit involves students gathering and exploring data and determining the appropriateness of using scatterplots to represent the data.

Community Connections

- Have a research scientist, statistician or stockbroker visit the classroom and share how analyzing for correlation is important in his or her field.

- Have your school superintendent discuss population trends and school construction plans.
- Have a pediatrician discuss growth charts and how these data are used.

Student Materials

Scatterplots: The Challenger Disaster

Additional Teacher Materials

- Diagram of Stretch Program Setup
- Graphing Calculator Directions: Stretch Program