Understanding Graphs and their Uses

Level 9-12

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Introduction to Bar Graphs

Age
7 to 8 years old

Direct Aim
Introduce bar graphs concretely.

Indirect Aim
Prepare children to analyze information from bar graphs, line graphs, and pie charts. Introduce range, median, and mode.

Materials
Some children of different heights and a few that are of the same height, yarn, paper for labels, measuring tape

Procedure
1) Inform the children that today you are going to use a different type of graph. On a large space on the floor, layout a horizontal piece of yarn. Beneath the yarn, place the names of the children used in the demonstration. To the left of the horizontal yarn, lay a vertical piece of yarn.
2) Ask each child to lie on the floor above their name tag. Measure the height of each child with the measuring tape and record the height on a separate label. Place the height labels, chronologically from least to greatest on the vertical axis. Tell the children that each of their bodies is like a "bar" and if you look at the whole graph, you can read information about each of the heights of the children. A bar graph shows information by the use of colored bars. They are used to compare pieces of information. Show the children the nomenclature.
3) Ask the children if you were to measure the length of their arms, what information would remain the same in the bar graph (the names of the children) and what would change? (the measurement of their arm length) In a bar graph, the information that remains the same is often on the horizontal line and we name it the dependent variable (x). The information that changes is usually on the vertical axis and is named the independent variable (y). Label each axis and show children the nomenclature for these terms. Ask the children the following questions.
4) Are there any children who are the same height? How many are there?
5) Which child is the shortest? Which child is the tallest? Which child is in the middle?

Follow up
Provide children with activities to interpret bar graphs and to make their own.

Introduction to Graphing Stories
Strike the Imagination

Age
8 years old

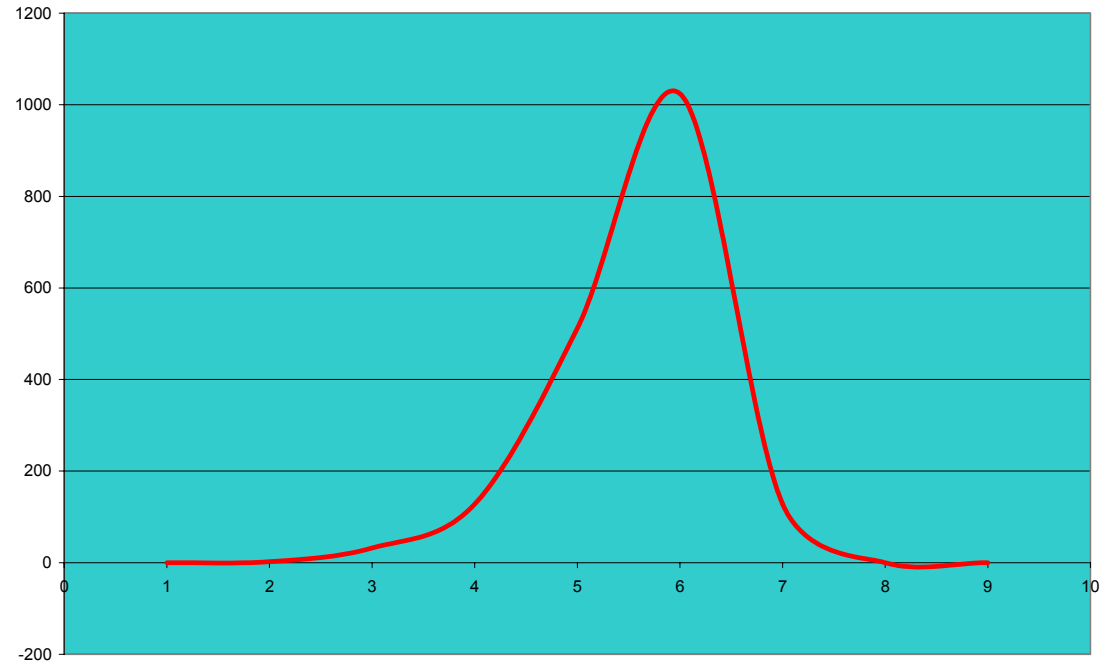
Direct Aim
Introduce that line graphs can tell a story.

Indirect Aim
Prepare children to analyze information from line graphs. Introduce range, median and mode.

Materials
Set of nursery rhymes on separate cards, half page line graphs

Procedure
1) Inform the children that today you are going to use a different type of graph. A line graph is a graph that may have one, two or more lines on it. Each line will tell a story.
2) Read each nursery rhyme and associate a line graph that shows that story.

Follow up
Graphing stories task cards.



Introduction to Line Graphs

Age
9 or 10 years of age

Direct Aim
Introduce children to using a line graph with comparative data.

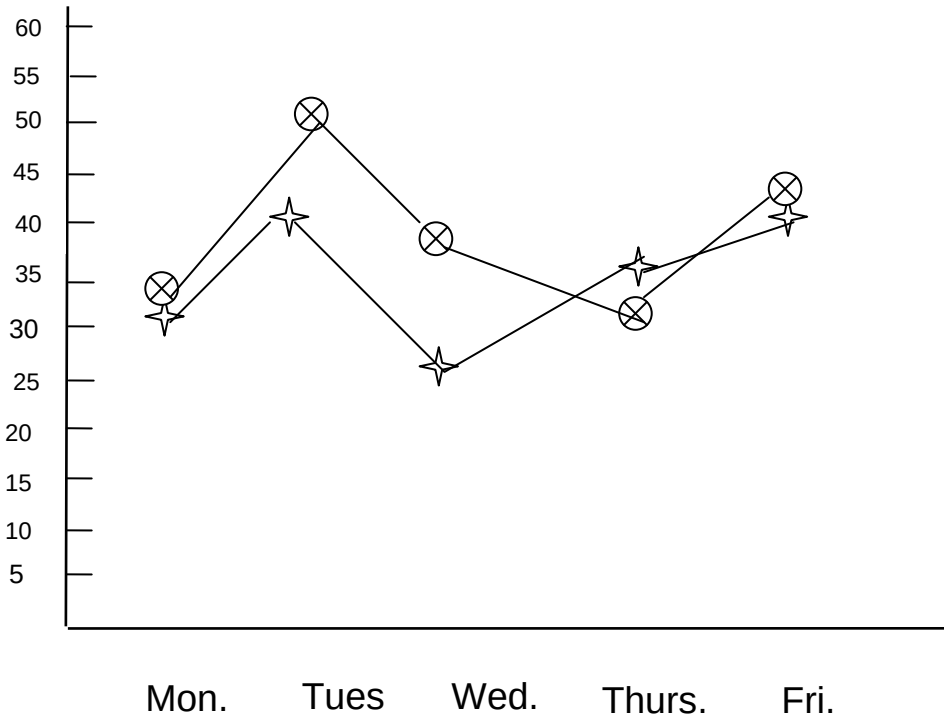
Indirect Aim
Develop communication skills in interpreting information between two or more sets of data. Interpret information in a word problem and represent it graphically. Reading information from a table.

Procedure
1) Ask the children if they found it difficult or time consuming to make the bar graphs. There is another type of graph that will allow them to show the same information, AND be able to compare information in a different way. Read the children the following story, making sure to record pertinent information along the way.

Taylor and Kaitlin were playing during recess. Each one of them took turns trying to jump rope as many times as they could, without missing. They decided to have a friendly competition to see who could jump rope the most, consecutively, and they decided to keep track of their scores for one week to see who could jump rope with the most skill. Here are the results of their jumps for one week.

	Monday	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
Taylor	*32*	*41*	*25*	*35*	*40*
Kaitlin	*34*	*52*	*38*	*31*	*39*

2) Ask the children how would you represent this information on one graph? How could you differentiate between the two children jumping? What are your dependent and independent variables? Lead the children in designing a graph that is similar in structure to the following graph.



Taylor Kaitlin

Many pieces of information may be ascertained from this graph. Sample questions that may be asked of the children could be;

1) Who had the most jumps and on which day?
2) On which day, did both girls jump fewer times than the day before?
3) On average, who is the more skillful jumper?
4) On which days, did both girls jump approximately the same number of times?
5) Which item is easier to read, the table or the graph? Why?

Follow up

1) Prepared task cards on line graphs
2) Prepared task cards on line graphs and cultural activities
3) Graphing Stories

Strike the Imagination Story
Rene Descartes and the Merging of Geometry and Algebra
(*Adapted from Marvels of Math, Kendall Haven, Teacher Ideas Press, 1998)*

Rene Descartes was born a sickly child and spent many of his early years in bed. This soon became a habit, and while he grew up to be a strong, healthy man, his preference for lying in bed, throughout the morning stayed with him, much to many people's dismay.

"SERGEANT! WHERE IS CAPTAIN DESCARTES?" thundered Colonel Gasper.

"I believe he is still in bed, sir," answered the aroused Sergeant.

"But, it is after ten in the morning! Go and fetch him immediately…..NO, never mind, I shall go get him myself!"

Stomping into the Captain's tent, Colonel Gasper was surprised to see Rene still lounging in bed, apparently unperturbed by the Colonel's entrance.

"I need to see all officers in my tent, immediately, why are you not up yet?" asked the frustrated Colonel.

"I had the most confusing dream," answered Descartes, "I dreamt that there was a savage war taking place; a war between good and evil. People were screaming and asked for mercy, but I was not afraid. Do you know why I was not afraid? Heaven had given me a golden key."

"A key? What kind of key?" asked the Colonel.

"It was the key to the understanding of all nature."

"What the devil does that mean? What was it?" asked the frustrated Colonel.

"The key was to use algebra and geometry together, to combine all of mathematics into one system to describe and explain the universe," answered Descartes with a faraway look on his face.

"This is about mathematics! You are still in bed, because you are dreaming about mathematics? Sir, we have a war to fight, I suggest you get dressed immediately and keep your mind on the problem at hand! Mathematics, indeed!" The frustrated Colonel turned around and quickly marched out of the tent, followed by a smiling Sergeant.

A year an a half later, Rene Descartes was transferred to the Bavarian army, which was far more engaged in battle than his previous assignment. Each attack was met with a counterattack, and many lives were lost to gain a few inches of charred soil. It was an early August morning of 1620, when Rene met up with his leader. "Major Haflen, may I have a word please?"

With cannons roaring around him, the Major snapped back, “I’m a little busy right now, Captain, so unless this has to with how to reposition the cannons to break through this fortified wall, I suggest you find another time to discuss your idea!”

“But, I think you will find this fascinating, I really do.” The young Captain climbed the small hill to be beside the artillery Major, and continued his story. “I was lying in bed this morning and I realized that for all regular three-dimensional objects, that it is true that the number of vertices, or corners, plus the number of faces, minus the number of edges, always equals two! It’s amazing, for any shape, it will always equal two!”

The Major looked at Descartes with disbelief. “This is why you climbed up here, in the middle of battle, to tell me this?”

“But don’t you see, it’s an algebraic equation that describes a geometric relationship. This might be the beginning of my bridge between geometry and algebra!” explained the excited Descartes. The Colonel climbed the hill to join the Major and Descartes. With surprise the Colonel asked, “Captain Descartes, I hope that we have not disturbed you with our *little war*. It is, after all, still early in the day.”

“Oh, not at all, sir, I do my best thinking in the morning, and it is well past noon.” A few days later, on a stifling morning, Descartes could be found lying on his cot, staring at the ceiling, on which moved a fly. “That fly is moving in small arcs through the air. It is making geometric shapes, and it doesn’t even know it,” thought Rene. “If I could some how measure, or describe each point of the fly’s path, I could write down the equation that would describe the fly’s arc.” Slowly, an idea emerged. “If I could do that, I would be able to translate algebraic equations into geometry!” He bolted out of bed, but how could he describe the fly’s location? HOW! Then it hit him. The fly landed in the corner, three inches from the back of the wall, and four inches from the side wall. Then he buzzed off again. Descartes fixed the fly again, six inches from the back of the wall and four inches from the side wall. With shock, Rene realized that he could describe the fly’s position at any time, just by using this idea. Better still, he didn’t need solid surfaces, if he used lines for axes, similar to the lines that were formed by the corner of the room, he could make a grid. Immediately, he saw the room framed off in a giant grid. Every point in the room could be described in this simple way. Borrowing a term from cartographers, Descartes called the distance of a point from the axes, a coordinate, and it is from this idea that we have the system termed “Cartesian coordinates”. With these coordinates, any geometric shape could be defined as a set of points, and in turn also defined as an algebraic equation and vice versa. Geometry and algebra had been merged, all thanks to a listless man, and a lethargic fly.

Introduction to Coordinate Planes

Age
9 years old

Direct Aim
Introduce a coordinate plane.

Indirect Aim
Prepare children to work with all four quadrants in a coordinate plane.

Materials
Strike the Imagination story of Rene Descartes, plastic fly, coordinate grid nomenclature

Procedure
1. Read the story of Rene Descartes to the children.
2. Introduce the nomenclature for the coordinate plane.
3. Start with the x and y axis and label these portions.
4. Follow this by labeling the different scales for each axis. Make note that the scale maybe in increments of one, five, ten or different for each axis.
5. Have the children notice the numerals on the axis and that they are both positive and negative.
6. Introduce the names of the quadrants. Quadrant I is in the top right corner, and each quadrant is named consecutively as you move counter-clockwise.
7. Explaining how a point is named on the grid first by its “x” coordinate and then by its “y,” call out various coordinates for the children to place the plastic fly. Start with placing the fly within the “body” of the quadrant. Ask the children to name the quadrant, then the coordinates.
8. As a final step, place the fly either on x or y axis. Ask the children to name this coordinate.

Follow Up
1) Prepared task cards on coordinate planes and Rene Descartes
2) Work with the Geometry/Algebra timeline.

Solving for Area Using a Coordinate Plane

Age
5th level students

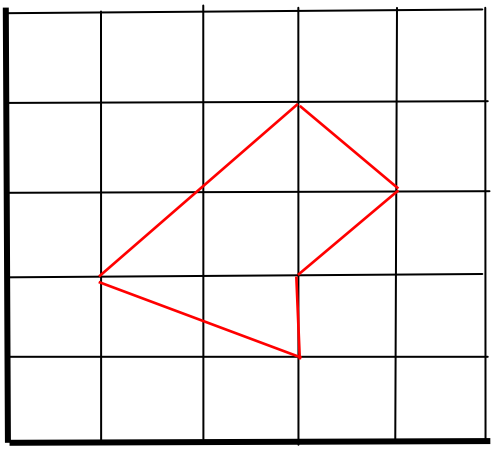
Direct Aim
To use coordinates to calculate the area of a given polygon.

Indirect Aim
Prepare children to use coordinates for linear graphing.

Materials
A labeled coordinate grid on which a polygon is drawn

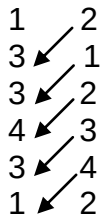
Procedure

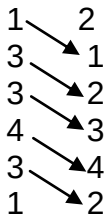
1) Inform the children that thanks to Descartes' creation of analytical geometry we are able to find many simple solutions to different problems.
2) Look at the polygon placed on the grid below.



3) Choose any vertex and list the coordinates counterclockwise. List the initial pair of vertices again.
4) The above vertices would be as follows:
(1,2) (3,1) (3,2) (4,3) (3,4) (1,2)

5) Using this list, find the diagonal products from left to right, then find the diagonal products from right to left.





6) Add each column of products.

6	1
3	6
8	9
9	16
+4	+ 6
30	38

7) Find the difference and divide by 2.

$$\frac{38 - 30}{2} = 4 \text{ square units}$$

Follow up activities

1) Prepared task cards- when using all four quadrants for this activity, the children must be fluent in multiplication of negative numbers.

Introduction to Scatter Plots

Age
9-10 years old

Direct Aim
Introduce the use of scatter plots.

Indirect Aim
Prepare children for use of linear graphs.

Materials
Tape measure, coordinate grid, prepared nomenclature

Procedure
1) Tell the children that you are going to use their previous work with coordinate grids to show information. And, you want to see if there is a relationship between the size of a person's wrist and their age.
2) Take the measurement of each child's wrist as well as your own. Decide whether to use metric or customary measurements.
3) Ask the children what the dependent variable is, and what the independent variable is.
4) Show nomenclature and discuss definition for each of these terms.
5) Discuss the scale used for each of the axes. Ask each child to state their age noting both the years and the months. For example, a child who is 9 years and 6 months would record their age as 9.6.
6) Plot each piece of data on the grid. Analyze the scatter plot to assess the correlation between a person's age and their wrist size. Ask the children if there is a positive or a negative correlation. Is there an "imaginary line" or grouping of the plots?
7) "Do they form a "line" from the origin up with higher values on the *x* and *y* axes?" If so, then there is high positive correlation.
8) Introduce the remaining nomenclature for the different types of correlations. Decide which type of correlation your particular graph shows.
9) Ask the children, what would be a statement that we could make regarding a child's age and the size of their wrist.

** Note, these graphs may be made either with an Excel program or on the graphing calculator. Giving children the experience to use the current technology is invaluable. It is suggested that in the follow up task cards, that you direct the children to use either one of these tools.

Follow up

1) Repeat the experiment making two separate scatter plots, one for females and one for males. Is there a difference in the correlation?
2) Follow up task cards.

Introduction to Stem and Leaf Plots

A stem and leaf plot is another way to display information grouped in intervals. The individual data values may still be identified in these graphs. A typical stem-leaf plot might look like this:

0	
1	1
2	3 3 6 9
3	1 1 3 4 4 5
4	0 0 3 5 6 9
5	4 4
6	0
7	6
8	3 3

The number 3 1 would actually represent 31, and the numerals in the set would include, 31,31,33,34,34, and 35

Age

11 or 12 years old

Direct Aim

To introduce using stem and leaf plots, and reinforce the median, range, and mode.

Indirect Aim

Recognizing the interrelationships between graphic elements and the way these elements impact the form of the graph. Preparation for work with histograms.

Material

A deck of cards for each pair of students, tally sheet.

Procedure

1) Pair off students and hand each set a deck of cards.
2) Pass out the cards evenly to each student, face down.
3) Play “War” where each child turns a card face up revealing its value. The person with the highest card wins.
4) Each player will record on their tally sheet the sum of the two cards that they won.

5) If the two players both turn up the same face value card, they will play “War,” where three more cards are placed face down and the 4th turned up. The player with the highest card will win all of the cards played.
6) Once all the cards from the deck have been played, have the students organize their data in a stem and leaf plot.
7) What were the most common pairs? What was the range between the highest card value and the lowest?
8) What is the likelihood that you will receive a pair totaling over 15?

Follow up

1) Prepared task cards

Introduction to Histograms

Age
11 years

Direct Aim
Introduce children to constructing a histogram.

Indirect Aim
Statistical analysis of data

Materials
One inexpensive water pistol for each child, tape measure, outside area (preferably concrete)

Procedure
1) Give each child a filled water pistol. Tell the children that you are going to collect data on how far the water will stream with one squirt.
2) Have children pair off, one to shoot the water, and one to measure the distance. Have the children take three tries with each water pistol and record the length of each stream.
3) Have the children come together as a group to share their information.
4) Inform the children that a histogram is a graphical way to show groups of data in a bar graph form. It is a combination of a stem and leaf plot with a bar graph.
5) Show the children the nomenclature on a histogram and discuss the definition. What is the "grouped" information on this particular activity? (The three tries of each water pistol)
6) "If we were to place this on a coordinate grid, what would be on our *x* axis?" (Each separate water gun noted as the three tries)
7) "What would be our *y* axis?" (The length of the stream)
8) "What do we need to do to combine our data?" (Get a "average" of the three distances)
9) Discuss which method the children want to use to get this "average" and why one would be preferable over another. (You will probably want to do the mean.) Have the children calculate this value. On one master grid assign the scale for the *x* axis and for the *y*.
10) On the *x* axis, place enough space for each bar to indicate the three tries.
11) Measure the height of the bar to represent the "average" length of each water stream.
12) Label each scale on each of the axes.
13) "What does your histogram tell you about the different lengths of each water stream?"

14) “What do you think are the reasons for the difference in water streams?”
15) “If you were to repeat the experiment with measuring the stream more than three times, do you think your histogram would look the same?”

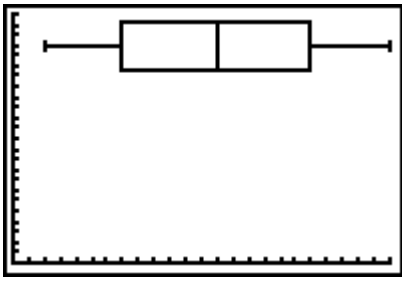
Follow Up

1) Repeat the analysis using the different ways to find the “average.” How does this change the histogram?
2) Complete follow up task cards.

Introduction to Box Plots

Box plots are a statistical way of displaying large amounts of data to identify basic information without having to sift through the details of the data.

A typical box plot looks like this:



The basic parts of a box plot are the lowest data value, the first quartile, the median, the third quartile, and the highest data value. Taken together these numbers are termed a 5 number summary.

Age
6^{th} level students

Direct Aim
Introduce students to reading statistical data and experience working with the median.

Indirect Aim
Lead students to making decisions about whether data should be left in a “raw” state or grouped in some way to reduce the data. Examples of grouping the data would be information gained from the U.S. census.

Materials
Chart with parts of a box plot, T-83 or T-84 graphing calculator,

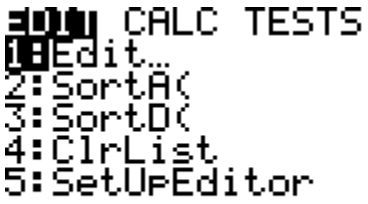
Procedure
1) Take the data and place the numerals in sequential order from least to greatest.

2) Find the median of this number set (this is the mid-number of the set of numerals). In a series of odd numbers, this is relatively easy.
In a series of even numerals, take the two middle numbers, average them, and use this as your median.

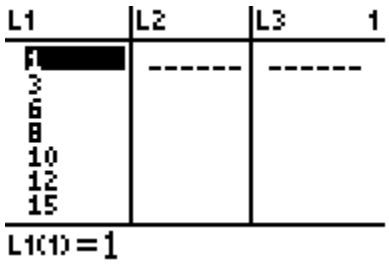
e.g.
1,3,6,8,10,12,15,17,19,20,23 = 12 is the median
1,3,6,8,9,10,12,15,17,19, 20,23 = 10+ 12 =22/2 = 11 is the median.

3) Now, looking at the lower set of numerals, 1,3,6,8,10, find the median of this set. (6) This is the limit of quartile one. Find the median of the upper set of numerals (19) this is the limit of quartile three. This is the system used when the median is *not* part of the original data set. To calculate the limits of the lower and upper quartiles when the median *is* part of the original data set, average the numbers including the median.
4) The *range* is when the smallest value is subtracted from the greatest value. The *interquartile range* is when you subtract the first quartile from the third quartile. This represents the middle 50% of the data and determines the length of the box. This can then be drawn on a graph by hand, or more simply done on the graphing calculator.

Press the [STAT] key and the following screen will be displayed.

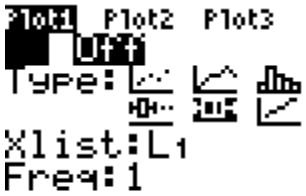


Press enter (or 1) to select the lists. There is room for 6 lists. Enter your data in chronological order.

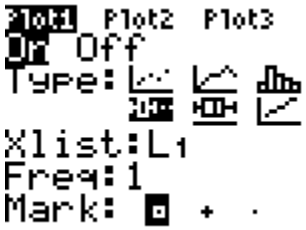


To make a box plot of this data, press [2nd] [Y=] to display the STAT PLOT menu which looks as follows:

You will see that there are several plots, make sure that all plots are off. If any are on, as displayed on this screen, enter 4 to turn off the plots.
Press ENTER to select PLOT 1. The following screen will be displayed.



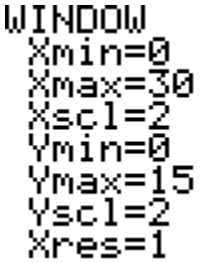
Move the cursor and press enter to turn this plot on. Now you may choose a graph from 4 choices: scatter plot, line graph, box plot or histogram. Move the cursor to the box plot and hit Enter



Now you must tell the calculator in which list the data is. Move the cursor to L1 and press ENTER

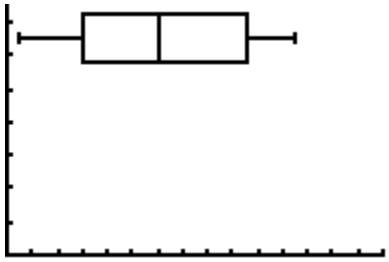
Now you need to set the values for the window that will display the graph. Press WINDOW

Set the values for the following: (Children may experiment with the different values and see how their graph changes.)

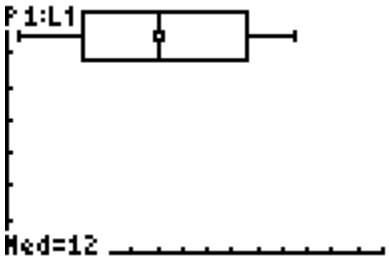


Now press GRAPH .

The following box plot will be displayed.

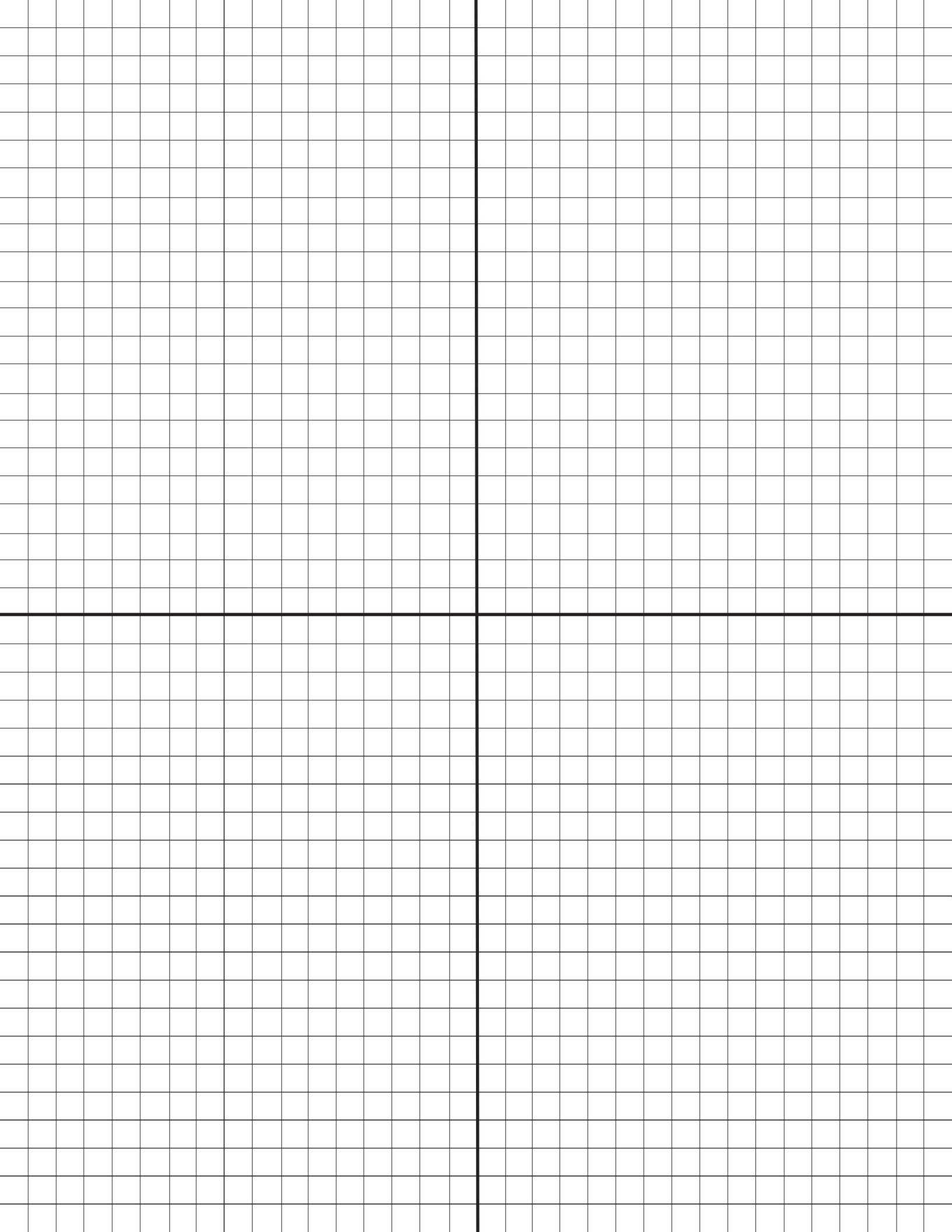


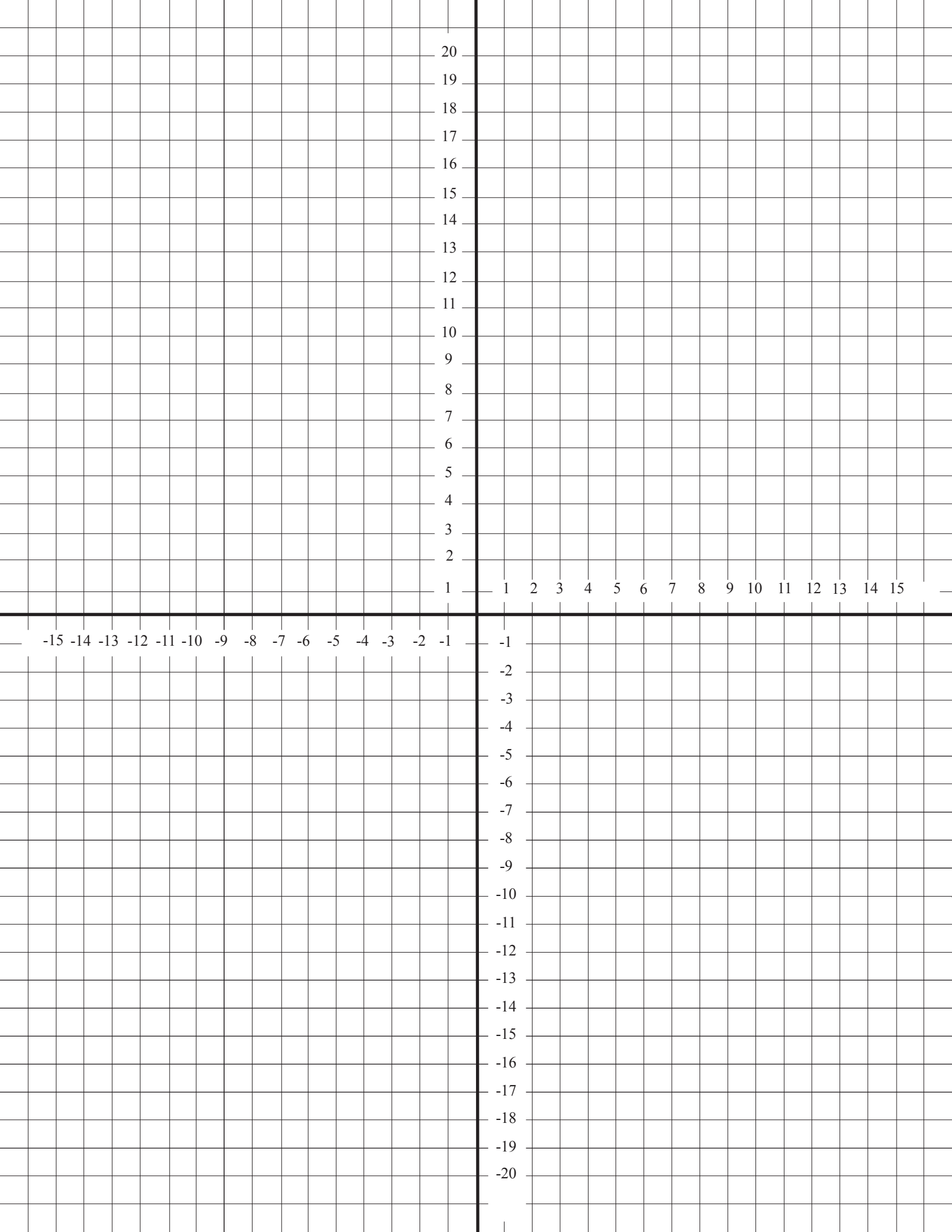
By hitting the TRACE button, the values for each one of the quartiles, the median, and the outliers are displayed in the lower left-hand corner.



Follow Up

1) Prepared task cards.

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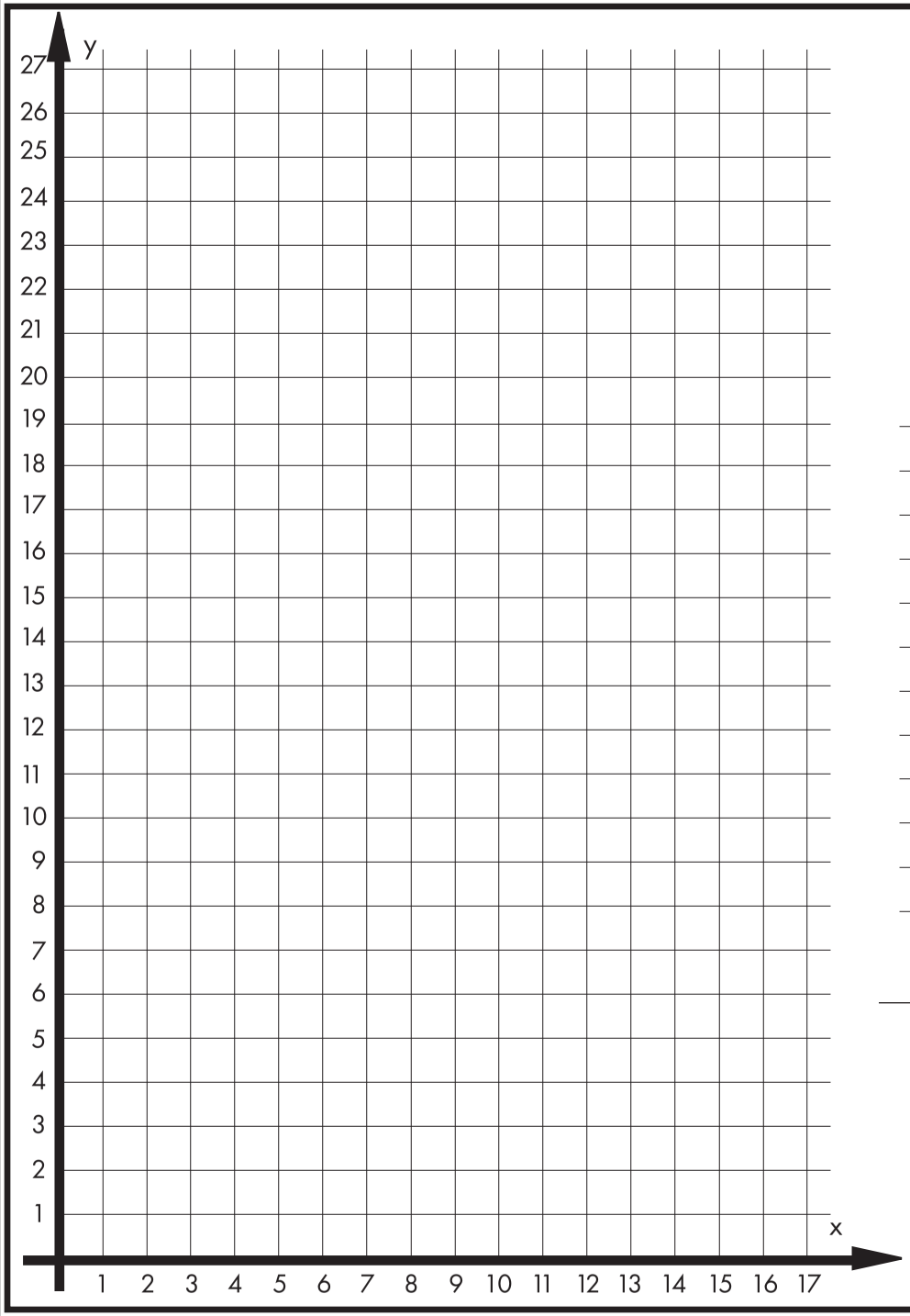
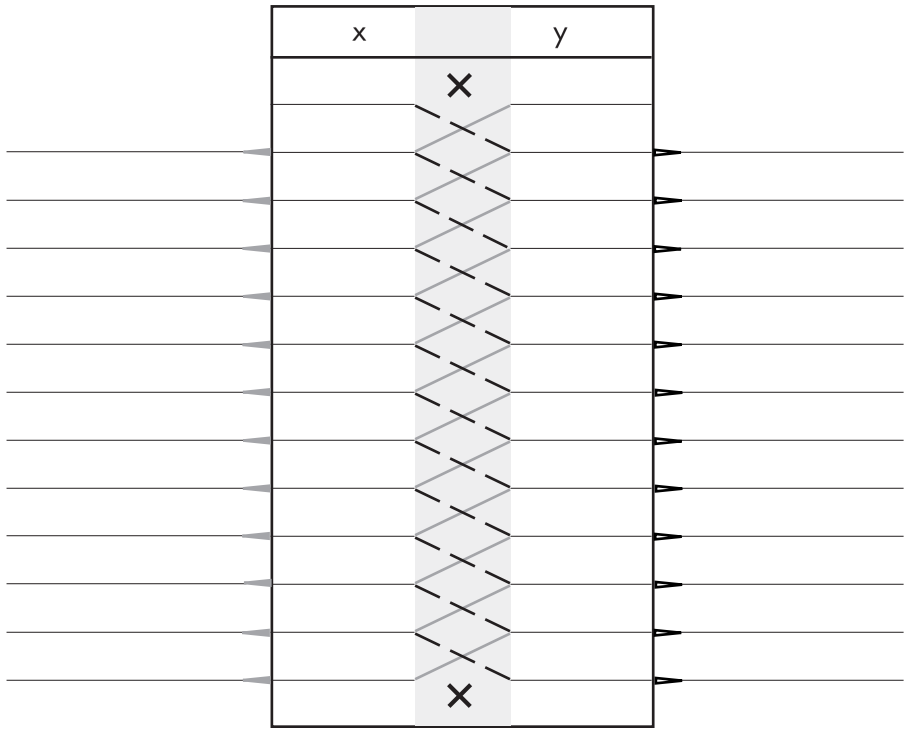


Worksheet

Coordinates

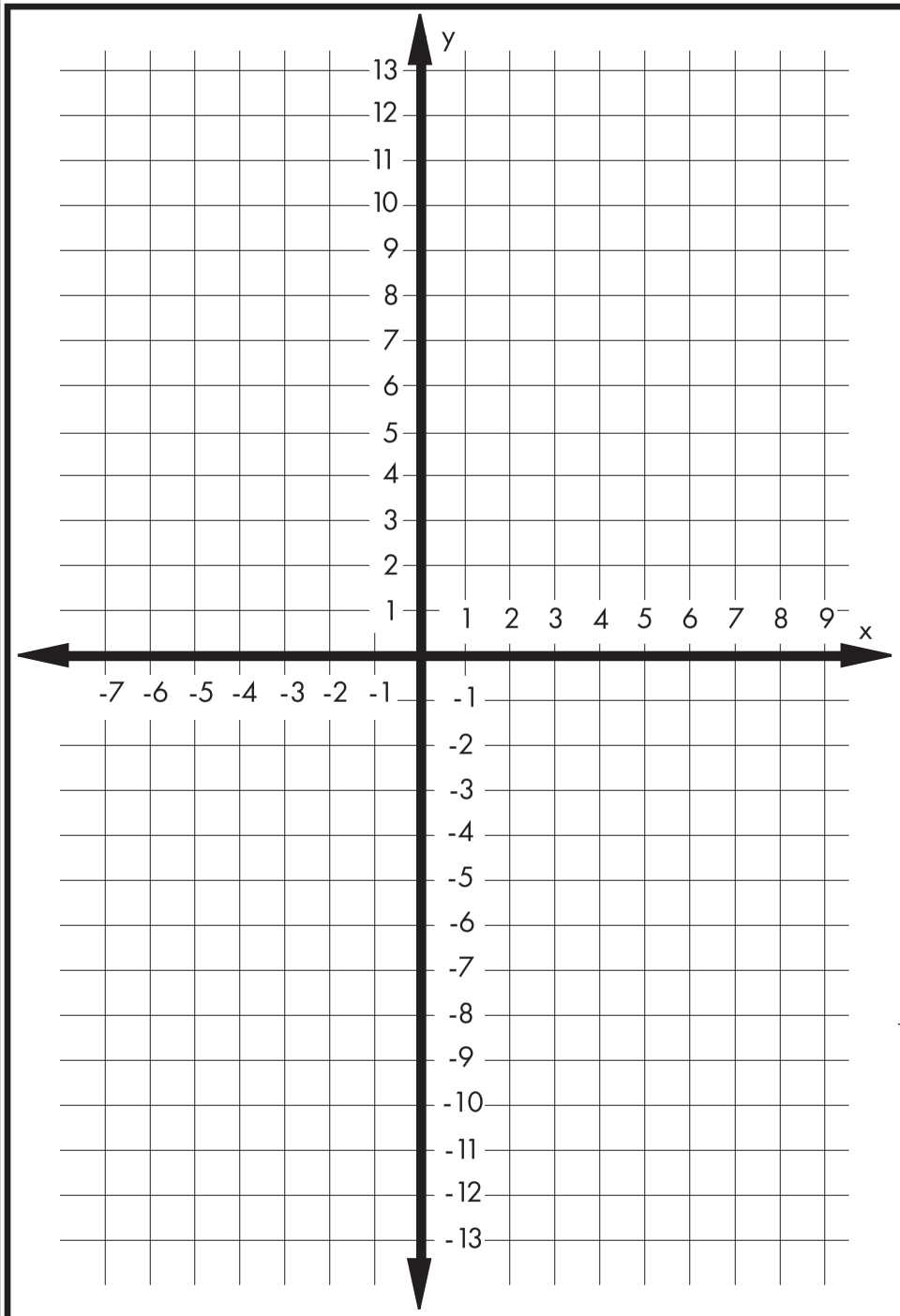


_____ = Sum of Products = _____

_____

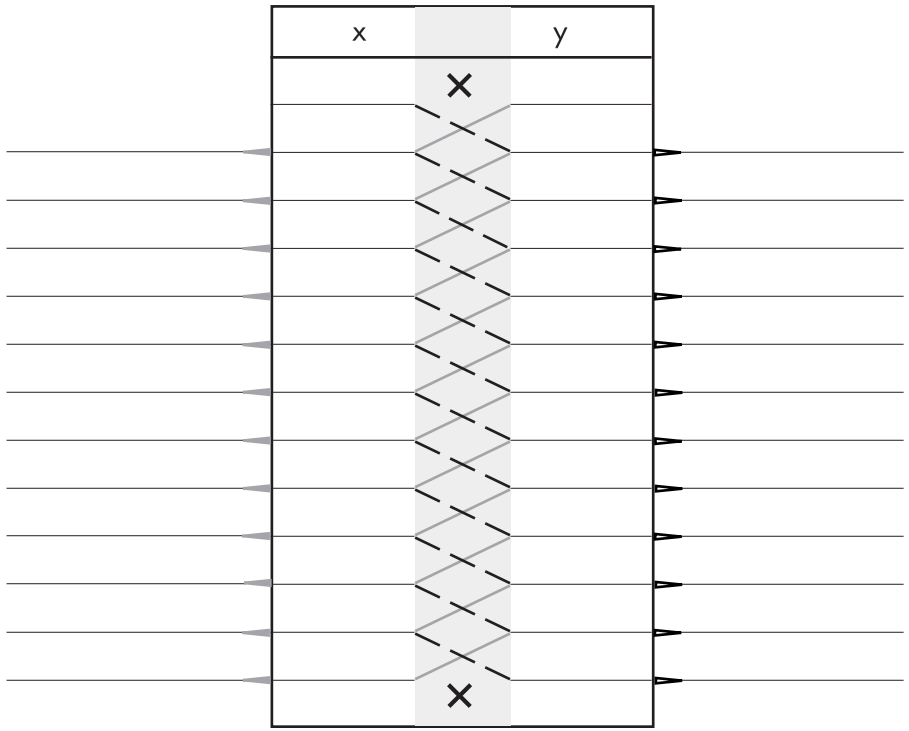
Find the Difference betweeen the Products

Divide the Difference by 2 = _____ (This is the Area of the Polygon)



Worksheet

Coordinates



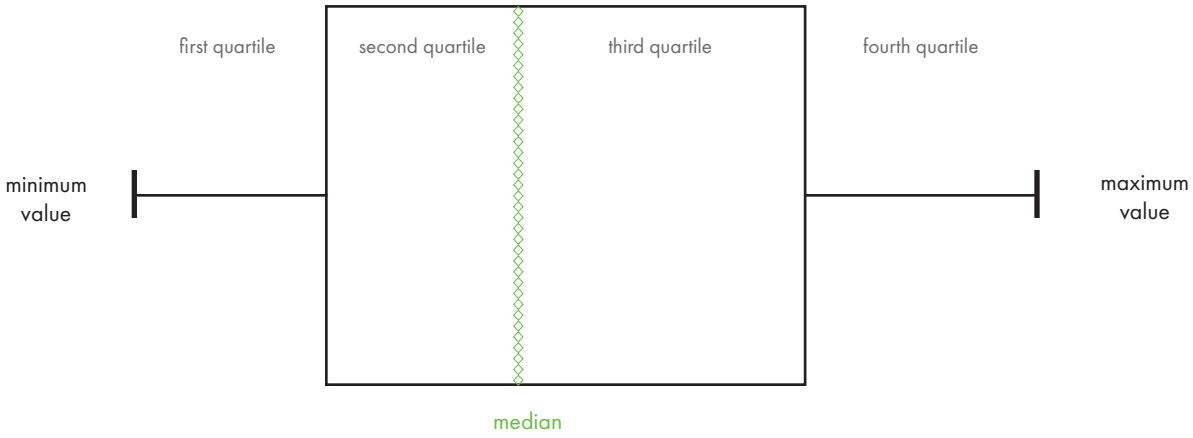
_____ = Sum of Products = _____

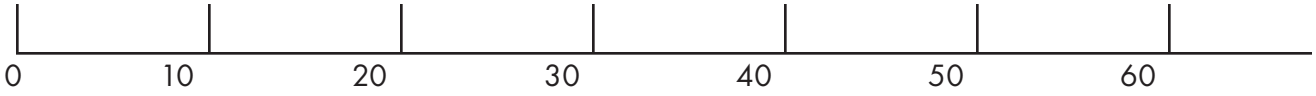
_____

Find the Difference betweeen the Products

Divide the Difference by 2 = _____ (This is the Area of the Polygon)

Parts of a Box Plot





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