SESSION SIX
HUMAN GRAPHING

Outcomes

- To develop conceptual understanding of ordered pairs on a graph
- To become aware of terminology associated with coordinate graphing
- To transfer the information from a table to a graph
- To become aware of different types of graphs, specifically linear and quadratic

Overview

In this session participants are introduced to the more formal aspects of graphs: coordinate points, terminology, and linear vs. nonlinear graphs. These concepts are introduced through the forming of a human graph. Participants explore how the rules of equations affect the shape of the graph.

Time

5–10 minutes	The session begins with a discussion on the assignment from the previous session.
10–15 minutes	The concept of coordinates and plotting coordinates is introduced by discussing a graph from the previous session.
50-65 minutes	A life size coordinate grid is used for human graphing. Axes, coordinates, quadrants, and graphing linear and nonlinear equations are introduced.
15–20 minutes	Participants graph tables from session one and discuss the graphs.
5-10 minutes	The session ends with a reflection on what was learned. An assignment is given.

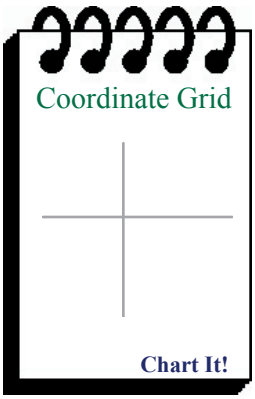
Materials

Facilitator	Transparencies (Eng. & Spanish)
• Masking Tape and 3 x 5 post-its® (to make horizontal and vertical axes on the floor) • 5 x 8 index cards, approximately 10 (for ordered pairs) • 3 x 5 index cards, 21 (for numbering on the axes) • Chart paper, 1" grid • Sentence strips • 20-25 ft. of rope	**Transparencies from Session 5** *BLM 25: The Bathtub Graph* *BLM 26: What Do They Tell You?* *BLM 28: At Home with Graphs, Tables and Rules*
Participant	**Handouts (English & Spanish)**
• Graph paper, 4 per participant	**One per participant for class** *BLM 27: A Menu of Pattern Activities with Answers* **One per participant for home** *BLM 28: At Home with Graphs, Tables and Rules*

Activities

Preparation of Classroom	Notes
1. Prepare the life size axes in an open area which can be inside or outside. The horizontal axis should have a minimum of a domain from –5 to 5. The vertical axis should have a range from –5 to 25 (to 16 will work) since x will be squared. Individuals will stand on each number on the horizontal axis, thus the numbers must be wide enough apart (about 18"). Each of the numbers should be at least 3" in size so that they can be read from afar. These can be made from 3 x 5 index cards. 2. Prepare index cards with ordered pairs on them. There should be 9: (3, 5), (5, 3), (8, 6), (6, 8), (1, 4), (4, 2), (4, -2), (-2, 4), and (-4, -2). 3. Prepare sentence strips with the following written on them: Horizontal axis (X-axis), Vertical axis (Y-axis), Origin (0, 0), "Add 2 to your number", "Add 5 to your number", "Multiply your number by 2", "Subtract 1 from your number", "Multiply your number by 2 and then add 2", and "Multiply your number by itself".	If there is not enough room to go to 25 on the vertical axis, then go to at least 16.
Discussion of Homework (5-10 minutes)	
1. Display a transparency of the previous assignment **What Do They Tell You?** 2. Ask participants to share their answers.	
A Look Back to the Bathtub (10-15 minutes)	
Numbering the Axes 1. Display a transparency of **The Bathtub Graph**.Remind them about the prior discussions by saying: *Last class we discussed this graph and decided that this axis represented ___ and the units were measurements of ___. We also decided that this other axis represented ____ and the units were measurements of ___.* 2. Use the discussion from the previous session to number the axes of the graph. 3. Use the numbers generated above to identify coordinates for specific point on the graph. Choose a point on the graph and say: *About how many minutes has the water been on and about how much water is in the tub?*	**The Bathtub Graph** is used to introduce coordinates in order to make connections between familiar and unfamiliar concepts.

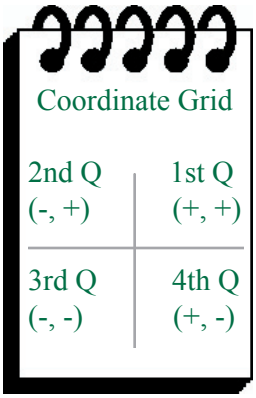
Activities

A Look Back to the Bathtub (continued)	Notes
4. After agreeing on a reasonable amount record this, e.g., 8 minutes and 6 inches. Write the ordered pair (8,6) by the marked point saying, *"This represents 8 minutes and 6 inches".* 5. Choose other points and repeat the process. 6. Give the participants a set of coordinates and have them locate it on the graph. *Where would the point (,) be? Mark it on your graph then compare your answer with someone else.* 7. Have someone come up and mark the point on the overhead transparency. Ask for agreement or disagreement. 8. Repeat this process. 9. Ask: • *Does every point on this graph have a pair of numbers that corresponds to it?* • *Do you think that all points on a graph have a pair of numbers that correspond to them?* 10. Let them know that they will now spend some more time on learning about points on a graph and graphing.	The goal of this activity is to develop conceptual undestanding of an ordered pair. The introduction of the terms associated with graphs will be done later.
Human Graphing (50 - 65 minutes)	
Introduction to the coordinate Grid 1. Have the participants gather at the life size grid. Let them know that this is called a **coordinate grid**. Write the term on the **Chart It!**. You may want to draw a grid next to the term as a reference. 2. Ask: *How is this grid similar or different from the bathtub graph?* The axes are extended to include negative numbers. 3. Let them know that they will be doing a little work with negative numbers and that those who have not had much experience with them will get some help from others.	 Draw the grid large enough to add other terms and points as they are discussed. You may want to introduce the four quadrants at this time.

Activities

Human Graphing (continued)	Notes
4. Identify the axes, record the terms on the **Chart It!** and have some volunteers walk the horizontal axis and the vertical axis. Place a sentence strip with the terms, horizontal axis (x-axis), and another one with the terms, vertical axis (y-axis), in the appropriate places. 5. Use the scenario of the bathtub to introduce the concept of the origin. Stand at the origin and ask, *At this point that I am standing on, how long has the water been running and how much water is in the tub?* 6. You may want them to discuss this in pairs first. After the discussion about zero minutes and zero amount of water, show the card with "(0, 0) origin" on it and place it on the origin. Add this information to the grid that was previously drawn on chart paper. 7. Show the index card with the ordered pair (3, 5) written on it. Ask: • *What would this mean in our bathtub story?* After getting a response ask for a volunteer to move to that point. • *Where should he/she start?* • *Where should he/she move first? Second?* Have them place the card at the point on the graph. 8. Ask: *What is the difference between (5,3) and (3,5)?* If no one brings up the bathtub coordinates as to why (5,3) and (3,5) are different, lead a discussion about the meaning of each number in relation to the bathtub problem. Have a volunteer place the index card of (5, 3) on the grid. 9. Show (8, 6) and (6, 8). Ask the participants to think about where they should be graphed. Ask for two volunteers to place them in the correct place. Continue in the same manner with other examples of positive coordinates. 10. Introduce coordinates in the other quadrants by asking where (-2, 4) might be. Continue with (4, -2) and (-4, -2).	As participants discuss the different vocabulary related to the coordinate grid, label the grid on **Chart It!** with the following terms as they are used: • **horizontal axis** • **vertical axis** • **x-axis** • **y-axis** Allowing them to compare and discuss their work gives them immediate feedback and releases the anxiety of sharing in front of the entire group. Now add the word "**origin**" to the coordinate grid on **Chart It!** This will be the first experience for some participants with integers. In the next activity, participants will be doing operations. One aim of this session is to create the need to know these rules. Out of curiosity, participants will ask each other how to compute with negative numbers.Thus an artificial "teachable moment" is created.

Activities

Human Graphing (continued)	Notes
11. As a summary for this section: a) Record some points and corresponding points on the coordinate grid **Chart It!**. b) Lead a discussion about the signs of numbers in each of the quadrants. c) Record the signs for the numbers in each quadrant on the **Chart It!** grid. 12. Clear all of the index cards from the grid and then check for understanding by standing on different points and asking the participants to name the coordinates. **Graphing Equations** 1. Choose or ask for 11 volunteers. Give each one a paper with one of the numbers from –5 to 5 written on it. Tell participants that they are to stand on their number on the horizontal axis. Say, You need to start at the beginning, the origin. Tell each person to begin at the origin and move to their respective number on the horizontal axis. Have each person face forward, towards the positive vertical axis. 2. Show a sentence strip that has written on it " add 2 to your number". Say: You need to add 2 to your number. Ask each person in the line what his/her new number is. Tell them to move up or down to the answer. 3. Ask everyone to identify points that participants are standing on. Then chart these points on grid paper for the **Chart It!** 4. Have the parents standing on the points hold a rope. When they have graphed y = x + 2, have them place the rope on the floor and move away. This allows everyone to see the line formed by graphing the equation. 5. Record this line on the new grid. Connect the points shared. Draw a line and label it y = x + 2.	 To allow everyone a chance to think, have them quietly check with their neighbor and then everyone say the answer to the count of 3. Help those standing on negative numbers by asking them to look down at the number they are standing on. To add 2, they need to look 2 places to the right of where they are standing. Now find that new number on the y-axis, and move directly up or down to it. If you do not have a rope, this activity can be done with a manipulative such as a large circle (diameter of about 8"). Have participants place the manipulative on their coordinate point and then move away. What they are being asked to do is to stand on x, perform an operation on x, and then move up or down to the y coordinate. They will then be on the point (x, y). It is sometimes helpful for someone to model this. You may want to model a second example where someone is standing on a negative number. Use a new coordinate grid with an x- axis from -5 to 5 and a y-axis from -5 to 25 to record the graphs.

Activities

Human Graphing (continued)	Notes
6. Some other equations to try are: • Y = x + 5 (add 5 to your number) • Y = 2x (multiply your number by 2) Record a set of points for each equation. Connect the points and label it. Using different colors of markers for each graph works best. 7. The following type of equation can be confusing to those who have negative numbers. Y = x – 1 (subtract 1 from your number). Before they do this one, it is helpful to ask: • *"If you are taking away one, is the number going to be smaller or larger?"* • *Which way should you move if the number is getting smaller?* 8. Other types of equations to try are : • Y = 2x + 2 (multiply your number by 2 then add 2) • Y = x^2 (multiply your number by itself) 9. Lead a discussion as to why this last graph was so different from the others. Make them aware that the first ones were lines and this last one was a parabola. Be sure to record these terms with a visual on **Chart It!**. 10. Let them know that they will now revisit some problems and investigate their graphs.	This has been a very good visual for the class but it can be difficult for one facilitator to lead the group and record at the same time. Some participants may be able to help. Displaying prior prepared graphs with the corresponding equation after making the human graph works well This can be confusing to participants so it is important that they know what number they are standing on and it is helpful to model the process. There are often errors especially with the negative numbers. If an error is made then they will not be standing in a straight line. Participants usually discuss among each other and correct any errors. If time permits try a series of equations that shows what happens to a graph when the slope is changed or when the y-intercept is changed.
A Menu of activities Revisited (15 - 25 minutes)	
1. Hand out graph paper and ***A Menu of Activities*** that has the tables completed for each. Have a discussion about how coordinates are read from the table. 2. If time permits have each person graph each problem. If time is limited, assign different groups to graph different problems using transparency graph paper or chart size graph paper. 3. Ask the participants to: a) Write the table on the paper b) Use the table to make a graph, and c) Write the rule for the table 4. Have presentations on the graphs. Point out which are lines, parabolas and exponential curves. 5. Add new terms to the **Chart It!** as they are discussed.	If the participants are working on all the graphs, identify ones that would be willing to present their work and give them transparencies of graph paper. Discussions that have arisen from this activity are: continuous vs. discrete, parabola vs. exponential, when it makes sense to graph beyond the first quadrant, etc. The group that presents Cut-Cut may think that the graph is a parabola. Have them compare their rule to the rule for Diagonals. It is helpful to have the Diagonals problem presented first.

Activities

Closure (5 - 10 minutes)	Notes
1. Ask each person to review the grids and the chart of terms and write about: a) Two things they learned during this class b) One question they still have 2. Ask for a few participants to share with the whole group.	
Take Home Activities (5 - 10 minutes)	
1. Distribute **At Home with Graphs, Tables and Equations** 2. Answer any questions about the assignment. 3. Tell participaants to be ready to share their experiences with this assignmnet at the next session.	
Preparation for the next Session	
1. Collect name cards if applicable. 2. Save the **Chart It!** and bring it to the next session. 3. Optional: • Type the notes on the **Chart It!** and distribute at the next session. • Take digital pictures of each chart. Prepare handouts of these pictures. 4. The charts that record the mathematical ideas for this session will be used in the next session.	