

## SESSION FIVE AN INTRODUCTION TO GRAPHING

### Outcomes

- To gain an intuitive feeling for graphing
- To explore the cause and effect of changes in a graph
- To understand the units of measure on the axes

### Overview

This session introduces graphing through the use of a motion detector called a Calculator Based Ranger (CBR) and a graphing calculator. These tools are used to graph and study the relationship between time and distance when an object is moving. Through this discussion, they are introduced to the labeling and scaling of the axes. Participants spend time analyzing the shapes of graphs and the causes for those shapes.

### Time

5 minutes	As participants arrive, they check the answers to their homework assignment.
15-20 minutes	Participants explore the relationships that are involved in graphing by making up stories to match graphs showing the amount of popcorn in a container over a two-hour time period.
20-25 minutes	Participants investigate the use of a graphing calculator and a motion detector. As they walk, the motion detector collects data and displays the graph of their walk. The instructor observes and asks questions to help them understand what is taking place. Time is given for participants to reflect on their learning.
20-35 minutes	Participants volunteer to walk and match a graph that is shown on the overhead projector. All participants study the graph and give directions/suggestions to the volunteer. The discussion that follows leads the participants to think about the axes, the measurements, the starting points and end points, the speed of the walk, etc.
15-20 minutes	Participants use the motion detectors again to practice what they have learned.
15-20 minutes	Participants are given a graph and a topic for the graph. They label the axes and use the graph to tell a story. Stories are shared.
5-10 minutes	The session ends with a brief discussion on the use of technology in today's classrooms. Assignments for home are given.

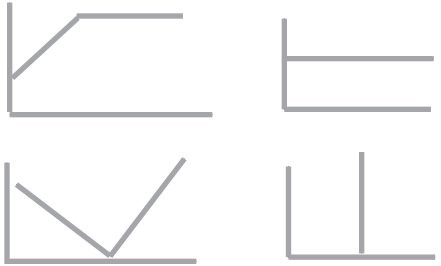
### Materials

Facilitator	Transparencies (Eng. & Spanish)
<ul style="list-style-type: none"> <li>• Charts from previous sessions</li> <li>• Overhead Graphing Calculator and Viewscreen</li> <li>• Chart paper with sample graphs drawn</li> </ul>	<p><i>BLM 22: Popcorn Graphs</i>  <i>BLM 25: The Bathtub Graph</i>  <i>BLM 26: What Do They Tell You?</i></p>
Participant	Handouts (English & Spanish)
<ul style="list-style-type: none"> <li>• Texas Instruments (TI) Graphing Calculators (TI 73, 82, 83, or 83+), one per pair</li> <li>• Calculator Based Ranger (CBR), one per pair</li> </ul> <p>(CBRs, calculators, and the Overhead Viewscreen can be borrowed from the TI loan program. Call 1-800-TI Cares.</p>	<p><b>One per participant for class</b>  <i>BLM 21: At Home with Expressions Answers</i>  <i>BLM 22: Popcorn Graphs</i>  <i>BLM 23.1-2: Instructions for the CBR</i>  <i>BLM 24: What Does It All Mean?</i></p> <p><b>One per participant for home</b>  <i>BLM 26: What Do They Tell You?</i></p>

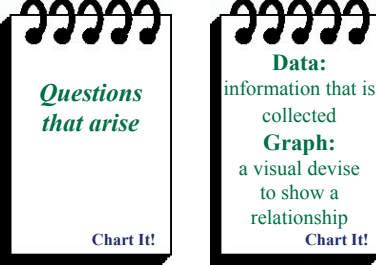
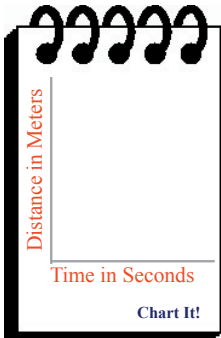
## Activities

Preparation of Classroom	Notes
<ol style="list-style-type: none"> <li>1. Have the <b>At Home with Expressions Answers</b> handout on the tables for the assignment from the previous session.</li> <li>2. Have one set of materials (graphing calculator and CBR) ready for each pair of participants.</li> <li>3. Have the calculator overhead viewscreen ready for the activities.</li> <li>4. Prepare a chart with sample graphs drawn (see Introduction to the CBR section).</li> <li>5. Set up the <b>Chart It!</b></li> <li>6. Distribute name cards (if applicable).</li> </ol>	<p>Prepare the graphing calculators by</p> <ul style="list-style-type: none"> <li>• Checking the power level of each calculator/CBR</li> <li>• Installing the Ranger program</li> <li>• Testing the brightness of the screen calculator</li> <li>• Checking that the Ranger program is working</li> </ul>
Discussion of Homework (5 - 10 minutes)	
<ol style="list-style-type: none"> <li>1. Have participants check their work with the answer sheets for <b>At Home with Expressions</b>.</li> <li>2. Discuss any questions that they have.</li> </ol>	
Popcorn Graphics (15 - 20 minutes)	
<ol style="list-style-type: none"> <li>1. Tell participants that tonight they will be exploring graphs and the relationship that can be described through graphing.</li> <li>2. Display the <b>Popcorn Graphs</b> transparency. Tell them that the first graph represents how you eat popcorn. Ask them what they know about how I eat my popcorn by looking at Graph 1.</li> <li>3. Have them work with a partner. Have them look at Graph 2 and discuss what they know about how this person eats popcorn. Have everyone share their ideas.</li> <li>4. Working with their partner, have them create a story that describes Graph 3. Have different partners share their story.</li> <li>5. Tell participants that technology is an excellent and fun way to discover the relationships in graphs. Most of the rest of the session will be spent with this technology.</li> </ol>	<p><b>Graph 1</b> Starts with a full bag of popcorn and eats it at a steady pace until it is gone.</p> <ul style="list-style-type: none"> <li>• <i>When was the first bite taken?</i></li> <li>• <i>How do you know?</i></li> <li>• <i>How fast was it eaten?</i></li> </ul> <p><b>Graph 2:</b></p> <ol style="list-style-type: none"> <li>a) About 10 minutes before taking the first bite is taken.</li> <li>b) The popcorn diminishes in chunks (handfuls?).</li> <li>c) The bag of popcorn is not finished.</li> </ol> <p><b>Graph 3</b></p> <ol style="list-style-type: none"> <li>a) Bag gets emptied after 1/2 hour (did it spill?) and then refilled.</li> <li>b) It is eaten quite a bit faster than the others.</li> </ol>

**Activities**

Introduction to the CBR (25 - 30 minutes)	Notes
<p><b>Introduction</b></p> <ol style="list-style-type: none"> <li>1. Have participants work in pairs with a CBR, a graphing calculator, and page 1 of the handout, <b>Instructions for the CBR</b> called Walking with the CBR.</li> <li>2. Tell participants to follow the instructions on the handout. They are to investigate how their walk affects the graph on the calculator. It works best if one person holds the CBR and the second person holds the calculator.</li> <li>3. Tell them that they should begin walking towards a wall and when they do they should try to keep the CBR as steady as possible. Do not tell them anything about distance.</li> <li>4. Give them plenty of time to investigate on their own. If some pairs need some help ask questions to guide them to some understanding of what is taking place. Some possible questions are: <ul style="list-style-type: none"> <li>• <i>What was happening as you walked?</i></li> <li>• <i>Why is that happening?</i></li> <li>• <i>What happens when you walk faster? Slower? Forwards? Backwards?</i></li> <li>• <i>How do you think that you can make the graph go up, go down, stay level, etc.?</i></li> </ul> </li> <li>5. Allow this investigation to continue until all or most groups are able to figure out what is happening as they walk.</li> </ol> <p><b>Sample graphs (Optional, if time permits)</b>  Show them 3-5 graphs (see sample graphs in notes) and ask them to try to make the graphs by walking. You can display these graphs on chart paper or on an overhead projector. Give them about 5 minutes to do this.</p> <p><b>What was this all about?</b></p> <ol style="list-style-type: none"> <li>1. Have all the participants sit and begin a discussion on their experiences. First, have each pair share what they have learned with another pair. Ask them to share any questions that they may have. Follow this with a whole group discussion.</li> <li>2. Have each group report out and record their comments and questions on <b>Chart It!</b>. Do not answer their questions now. Let them know that they will continue to investigate graphing and the activities may answer some of their questions.</li> </ol>	<p>Modeling the process with an overhead calculator will help, as many are completely unfamiliar with the calculators.</p> <p>The sample graph activity is fun, but optional, and can also be used as an extension for partners who develop a basic understanding quickly and need to be challenged.</p> <p>Some sample graphs:</p>  <p>The last graph is not possible and is given to lead to interesting conversations about what kind of graphs are possible and what are not.</p>

**Activities**

Introduction to the CBR (continued)	Notes
<p>3. From this discussion discuss the terms, graphing calculator, Calculator Based Ranger (CBR), data, graph, and any other terms that arise. Write the terms on the <b>Chart It!</b></p>	
Whole Class Exploration (20 - 25 minutes)	
<ol style="list-style-type: none"> <li>1. Tell the participants that they will now match graphs given to them by the CBR.</li> <li>2. Using the <i>Graph Match</i> on the CBR, display a graph. Ask for a volunteer to walk and match a graph that is shown on the overhead projector.</li> <li>3. If volunteers are hesitant to match the graph have the rest of the class study the graph and give the volunteer directions. Volunteers often try to match the same graph more than once.</li> <li>4. After a graph is walked ask the participants to discuss the following question in their small groups:             <ul style="list-style-type: none"> <li>• <i>What should the walker do to get a better match?</i></li> <li>• <i>What directions would you now like to give?</i></li> </ul> </li> <li>5. Repeat the process (steps 2-4) several times.</li> <li>6. Ask questions that will lead to more understanding about the graph and the walking instructions.             <ul style="list-style-type: none"> <li>• <i>Where do you think he/she should begin walking? Why do you think so?</i></li> <li>• <i>Where should they stop? Why? For how long?</i></li> <li>• <i>What will they have to do to match this part of the graph? How fast? Slow? How long?</i></li> </ul> </li> <li>7. Lead a discussion on the axes and the meaning of the tick marks on both the horizontal and vertical axes. You may want to ask them to discuss the following questions in their groups:             <ul style="list-style-type: none"> <li>• <i>What do these marks represent (Pointing to the tick marks on axes)? How do you know?</i></li> <li>• <i>How could we label this line (called an axis) to show what each tick mark represents? (Do this for both axes.)</i></li> <li>• <i>How should we title each line?</i></li> </ul> </li> <li>8. Draw both axes and label them appropriately in the <b>Chart It!</b>.</li> </ol>	<p>Instructions for the graph matching using the CBR are on page 2 of the handout <b>Instructions for the CBR</b> called Matching Graphs on the CBR (to be handed out after the whole class exploration).</p> <p>Set the CBR on a table that is about waist high. It is helpful to have the walking volunteer place a large piece of cardboard in front of him so that the CBR can get more accurate data. The back of the chart paper table works well for this.</p> <p>The horizontal axis represents time in seconds and the vertical axis represents distance (from the motion detector) in meters.</p> 

## Activities

Whole Class Exploration (continued)	Notes
<p>9. Show another graph. Give the participants one minute to individually think about:</p> <ul style="list-style-type: none"> <li>• <i>Where should the walker start?</i></li> <li>• <i>How fast should the walker go?</i></li> <li>• <i>How long should they go at that pace?</i></li> <li>• <i>Should they go faster or slower at this point?</i></li> </ul> <p>Have them discuss their ideas in their group. Ask for one person to volunteer to match the graph.</p> <p>10. Repeat step 9 one to two more times.</p>	<p>It is helpful that participants have some individual thinking time before group discussion begins.</p> <p>This time when you ask these questions, there should be more specific answers relating to the number of meters from the CBR and the number of seconds to get from one location to the next.</p>
A Second Try With the CBR (10 - 15 minutes)	
<p>1. Tell participants that they will now have a chance to see how much they have learned about graphing.</p> <p>2. Ask them to work with their original partner to match graphs using the CBR. Distribute the page 2 handout of <b>Instructions for the CBR</b> called <i>Matching Graphs on the CBR</i>.</p> <p>3. As they match graphs, walk around and check on their progress.</p> <p>4. If time permits, have participants reflect on their learning by completing the handout <b>What Does It all Mean?</b></p>	<p>Some of the graph matches by the participants are so exact that it is difficult to see both graphs.</p>
The Bathtub Graph (20 - 25 minutes)	
<p>1. Display transparency <b>The Bathtub Graph</b>.</p> <p>2. Tell participants that the graph displays data about a bathtub. Ask them to talk to each other in small groups and discuss the possible data that the graph represents.</p> <p>3. <b>Ask:</b> <i>What could the number on this axis represent? On the other axis?</i></p> <p>4. After giving them a few minutes to discuss, have them share their thinking and record their ideas on a transparency. Have the group decide how to label each axis. Remind them that they need to determine the units of measurement.</p> <p>5. Ask participants to think about a situation in their home that could occur based on this graph. They are to decide on a story for the graph.</p>	<p>You might also ask them to think about what could be changing in a bathtub situation. It helps to refer them back to their walking where the time (in seconds) and the distance (in centimeters) from the motion detector were changing.</p> <p>The horizontal axis is usually labeled time and vertical axis is usually labeled water level.</p> <p>This activity has been very engaging for the participants. It adds humor and lightheartedness to the session while applying new learning. Participants get very involved in these stories as they are often about their families, especially their children.</p>

**Activities**

The Bathtub Graph (continued)	Notes
<p>6. Invite several participants to share their stories. Have them use the transparency to point out different aspects of their story.</p> <p>7. Questions which can be asked of the presenters or the entire class are:</p> <ul style="list-style-type: none"> <li>• <i>What is this part of the graph showing?</i></li> <li>• <i>If the graph looked like this, what could have happened?</i></li> <li>• <i>Does anyone have a different idea about this?</i></li> </ul>	<p>Asking for different stories verifies that thinking differently is expected and encouraged. It helps parents take risks. Clapping after presentations shows that the presenter's thinking is valued and encourages others to share.</p>
Closing Activity (5 - 10 minutes)	
<p>1. End the session with a discussion on how technology has changed the teaching and learning of mathematics in today's classrooms.</p> <p>2. Ask participants to think about how this class would have been different if we had not had the calculators and the CBRs. Have them share their ideas.</p> <p>3. Tell the class that they will continue to work with graphing at the next session.</p>	
Take Home Activities (5 - 10 minutes)	
<p>1. Distribute the handout <b>What Do They Tell You?</b> Explain to the participants that they are to look at the graph and tell a story about the graph. Ask them to label the axes.</p> <p>2. Tell them to be ready to share their stories at the next session.</p>	
Preparation for the next Session	
<p>1. Collect name cards if applicable.</p> <p>2. Save the <b>Chart It!</b> and bring it to the next session.</p> <p>3. Optional:</p> <ul style="list-style-type: none"> <li>• Type the notes on the <b>Chart It!</b> and distribute at the next session.</li> <li>• Take digital pictures of each chart. Prepare handouts of these pictures.</li> </ul> <p>4. The transparencies <b>The Bathtub Graph</b> and <b>What Do They Tell You?</b> will be used in Session Six.</p>	