

Introductory Discussion Questions:

1. What types of graphs exist?
2. What can we use graphs for?
3. Why might we want to use graphs?

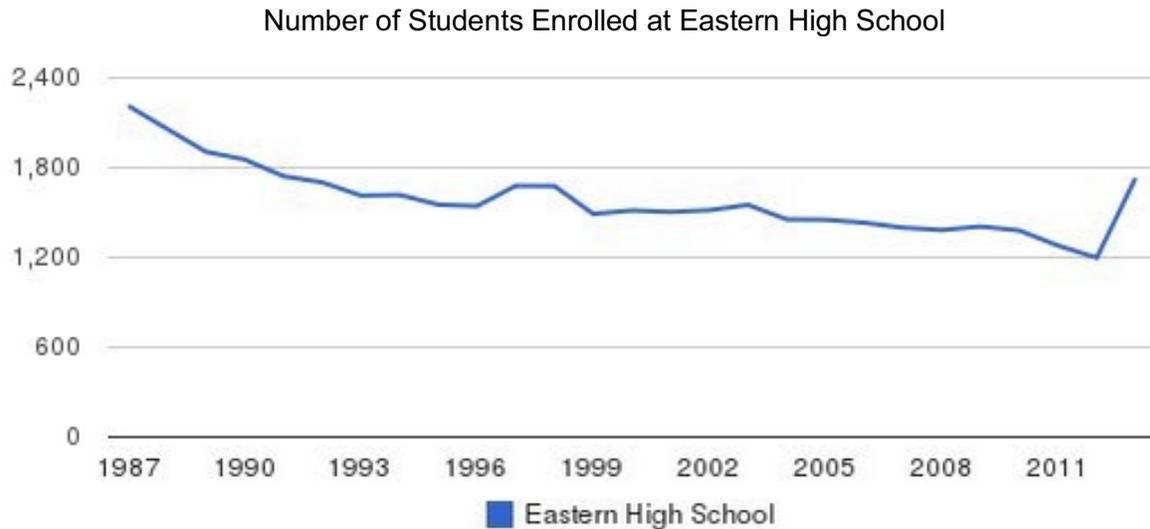
Discussion Points for after the task:

1. See Full Lesson Plan

Task Cards for students are below the task card notes. They do not include the graphs because graphs will be printed on cardstock and set as table tents on the tables so all students can see them and so that students can focus their attention on the questions and write their answers on the sheet(s) provided.

Task Card questions and notes for teacher reference:

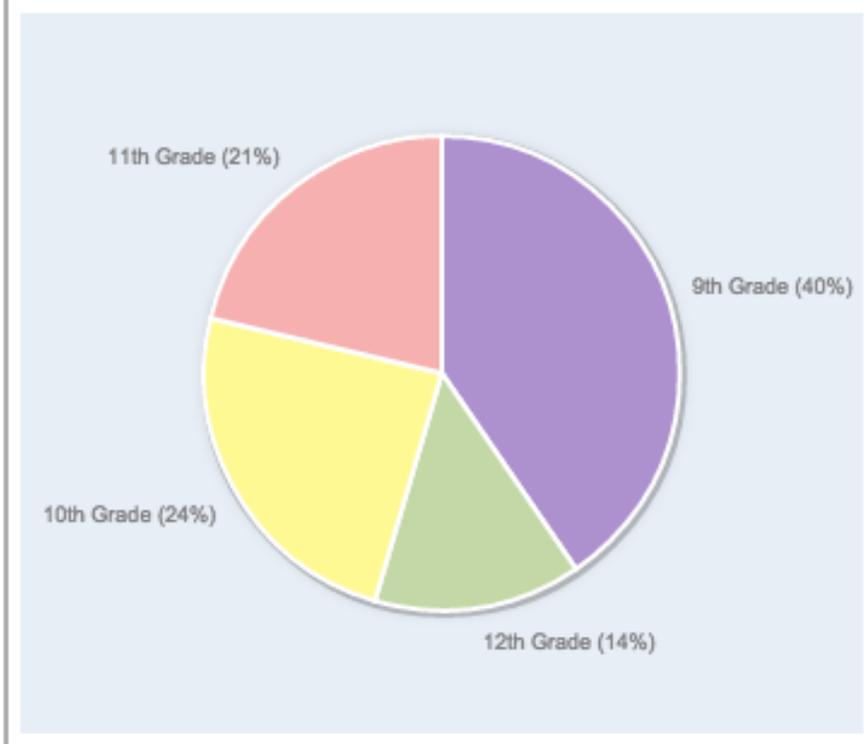
Instructions: Examine your graph and answer the questions that follow in your notebook.



1. What type of graph is this?
2. Identify 3 pieces of data that you can find in your graph.
3. Using your graph, estimate how many students attended Eastern in 2011. How many attended Eastern in 2002?
4. Recently, Eastern High School was 19% Hispanic, 35.9% Black, 7% Asian, and 35.9% White. The remainder were American Indian, mixed race, or belonged to another race. Using the most recent data on your graph, estimate how many students at Eastern belonged to each of these races.
5. Write 2-3 sentences describing what information your graph communicates. What does this mean to you as a student at Eastern?
6. Could you use another type of graph to show this data? If so, sketch one other possibility.

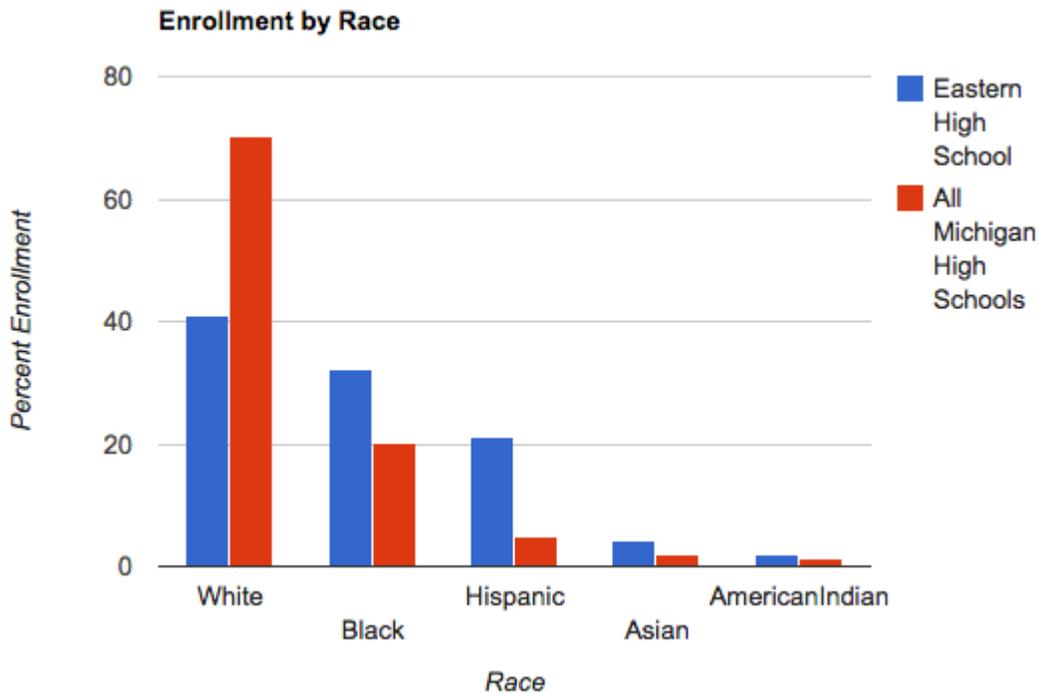
Instructions: Examine your graph and answer the questions that follow in your notebook.

Student distribution at Eastern High School



1. What type of graph is this?
2. Identify 3 pieces of data that you can find in your graph.
3. Using your graph, estimate how many students were in each grade if the total school population was 1,200. What if the total school population was 1,500?
4. If there were 200 students in 12th grade, how many students were in 9th, 10th, and 11th grades? Use your graph to estimate.
5. Write 2-3 sentences describing what information your graph communicates. What does this mean to you as a student at Eastern?
6. Could you use another type of graph to show this data? If so, sketch one other possibility.

Instructions: Examine your graph and answer the questions that follow in your notebook.



1. What type of graph is this?
2. Identify 3 pieces of data that you can find in your graph.
3. Using your graph, estimate the percentage of students at Eastern High School belonging to each of the races shown. If there were 1,600 students at Eastern, how many would belong to each of these races?
4. Estimate the percent difference in enrollment by race between Eastern High School and all Michigan high schools.
5. Write a paragraph describing what information your graph communicates. What does this mean to you as a student at Eastern?
6. Could you use another type of graph to show this data? If so, sketch one other possibility.

Instructions: As a group, discuss and respond to the following questions.

1. What type of data do we communicate with line graphs? With pie graphs? Bar graphs? Have each team member present what they wrote about what their graph communicates.
2. Given the following information, which type of graph most accurately communicates the data? Draw the type of graph you choose and write an explanation of why you chose that type of graph.

Graduation Rates at Eastern High School versus All Michigan High Schools		
	Eastern High School	All Michigan High Schools
Overall	71.0%	71.5%
Economically Disadvantaged Students	66.0%	64.5%
Limited English Proficiency Students	72.0%	83.5%
Students with Disabilities	40.0%	73.0%

3. Looking at your graph, what information does it communicate? What does it mean to you as students at Eastern?

Bonus Question: Sometimes graphs can be misleading. What aspects of your graph could you change to communicate a different message about the data? Make these changes to your graph and write what the new graph communicates.

Lesson by Anna Perrin, Tess Shavalier, & Kellie Stilson

Interpret your graph to answer the following questions:

1. What type of graph is this?
2. Identify 3 pieces of information that you can find in your graph.
3. Write 2-3 sentences describing what information your graph communicates. What story does this tell you as a student at Eastern?
4. What other type of graph could you use to graph this same data? Graph it. If you cannot think of another graph, write 2-3 sentences explaining why not.

Graph A

1. Using your graph, estimate how many students attended Eastern in 2011. How many attended Eastern in 2002?

2. In 2011, Eastern High School was 19% hispanic, 35.9% black, 7% Asian, and 35.9% white. The remainder were American Indian, mixed race, or belonged to another race. How many students at Eastern belonged to each of these races?

Race	Number of Students
Hispanic	
Black	
Asian	
White	
Other	

Graph B

1. How many students were in each grade if the total school population was 1,200. What if the total school population was 1,500?

Total Enrollment 1,200		Total Enrollment 1,500	
Grade	Number of Students	Grade	Number of Students
9th		9th	
10th		10th	
11th		11th	
12th		12th	

2. If there were 200 students in 12th grade, how many students were in 9th, 10th, and 11th grades? Use your graph to estimate.

Graph C

1. What percentage of students at Eastern High School belong to each of the races shown? If there were 1,600 students at Eastern, how many would belong to each of these races?

Race	Percent Enrollment	Number of students if 1,600 students total
White		
Black		
Hispanic		
Asian		
American Indian		

2. What is the percent difference in enrollment between students of each race at Eastern compared to all Michigan high schools?

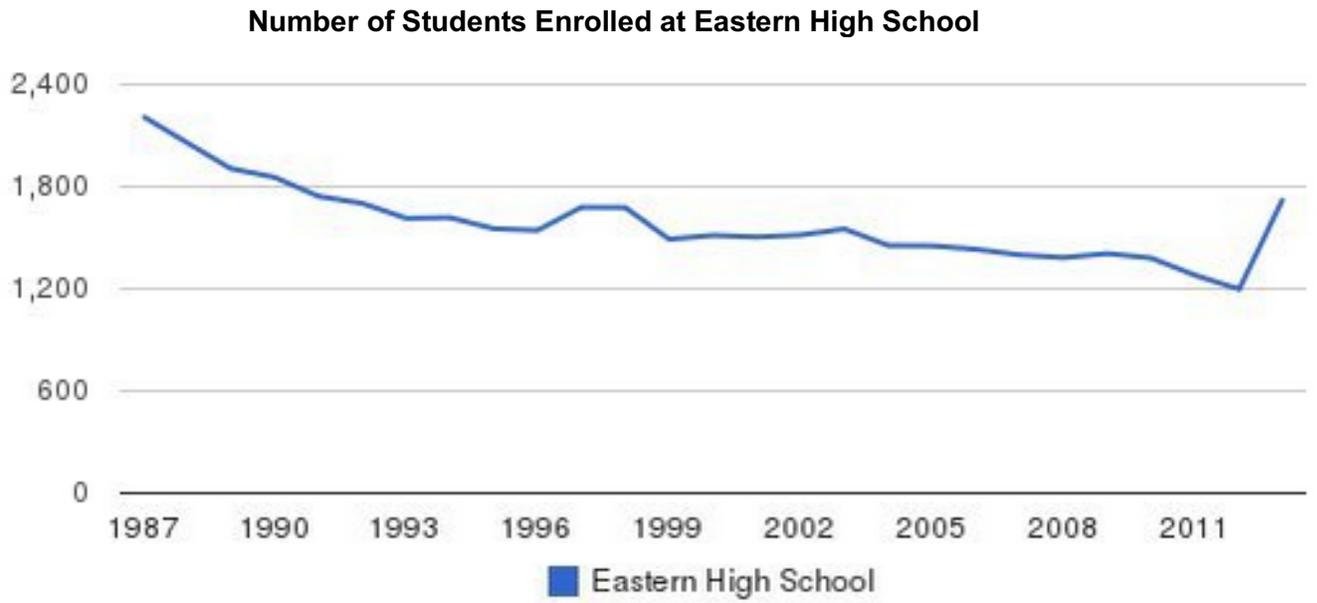
Instructions: As a group, discuss and respond to the following questions.

4. What type of data do we communicate with line graphs? With pie graphs? Bar graphs? How do these graphs tell “stories” in different ways? Have each team member present what they wrote about what their graph communicates.
5. Given the following information, which type of graph most accurately communicates the data? Draw the type of graph you choose and write an explanation of why you chose that type of graph.

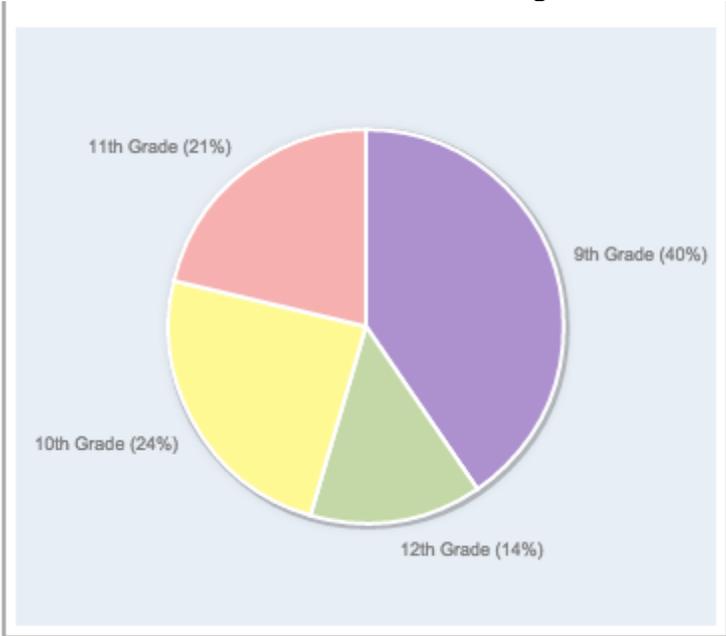
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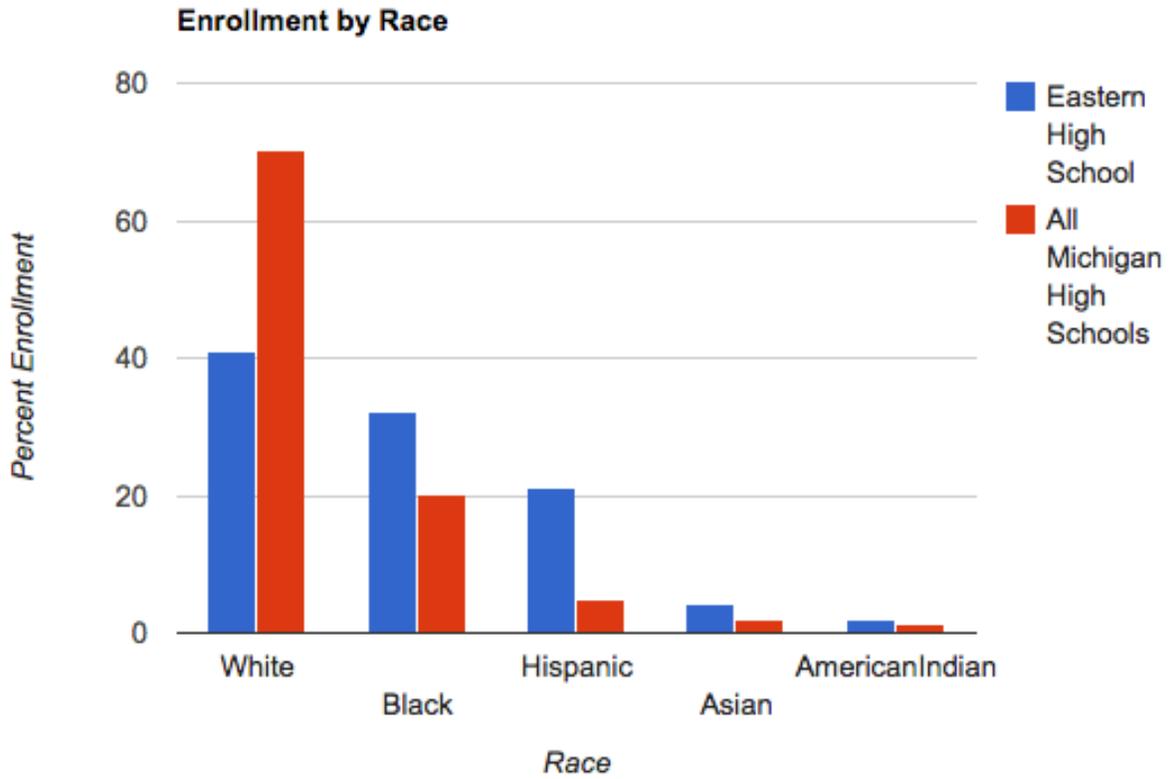
6. Looking at your graph, what story does it tell? What does it mean to you as students at Eastern?

Bonus Question: Sometimes graphs can be misleading (even purposely!). What aspects of your graph could you change to communicate a different message about the data? Make these changes to your graph and write the new story your graph communicates.



Student Distribution at Eastern High School





(Revisions are in purple)

Part o: Selecting and Setting up a Mathematical Task	
<p>What are your mathematical goals for the lesson (i.e., what is it that you want students to know and understand about mathematics as a result of this lesson)? What are the mathematics standards this lesson teaches? (http://www.corestandards.org/Math/)</p>	<p><u>Learning Goals</u></p> <ul style="list-style-type: none"> ● Students will . . . <ul style="list-style-type: none"> ○ Interpret and explain the data expressed in various types of graphs. ○ Determine and construct appropriate graphs to display data. ○ Describe the story that is being told by a graph and explain why it is important. <p><u>Standard(s) Addressed:</u> CCSS.MATH.CONTENT.HSN.Q.A.1</p> <ul style="list-style-type: none"> ● Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
<p>In what ways does the task build on students' previous knowledge?</p>	<p><u>Skills and Understandings</u></p> <p>Previously, students have worked with various types of graphs (including line graphs and bar graphs). They know many things - that they need axes, a title, a scale, etc, but struggle to interpret what the graph communicates. This lesson will help them to make sense of the ideas they already have about the different types of graphs. Additionally, the context of the graphs involves demographic information about the students at the high school.</p>
<p>What definitions, concepts, or ideas do students need to know in order to begin to work on the task?</p>	<p>Students will use their knowledge of various types of graphs (bar, pie, line), to interpret information from the graphs. Students will need to know where to find certain information (title, labels, keys) on the graph.</p>
<p>What questions will you ask to help students access their prior knowledge?</p>	<ul style="list-style-type: none"> ● What types of graphs exist? ● Where have you seen these graphs? ● Where besides math class have you seen graphs? ● What can we use graphs for? ● Who uses graphs and how? ● Why might you use graphs? (reading or creating) ● Who has ever seen a bar graph? What did it look like? What about a line graph? What can you

	tell me about pie graphs?
<ol style="list-style-type: none"> 1. What are all the ways the task can be solved? 2. Which of these methods do you think your students will use? 3. What misconceptions might students have? 4. What errors might students make? 	<ol style="list-style-type: none"> 1. Students will need to use their graph interpretation skills to obtain the required data points. The task is very open - students can pull any relevant data from the graph. Hopefully they notice things like the title, units on the axis, categories the data is sorted into, and perhaps the “reverse statistics” (if about 40% of students are white, then 60% must be a different race). Students may also remark on aspects of the graph like the color of the bars or wedges, the height of bars or slope of the line, etc. Since the information on all the graphs is relevant to the students at Eastern, they may make conclusions based on things that they know, regardless of if it is expressed in the graphs or not. 2. We anticipate that students will remark on specific data points and not immediately comment on the other important aspects of a graph listed above. We expect students to state the obvious at first. It will take some prodding, whether from us or from other group members to get to some of the deeper information out of the graphs. Later in the task (or the next day) when they discuss “misleading” graphs, then they will see the importance of the other information. 3. Students may... <ol style="list-style-type: none"> a. Think that any set of data with percentages can only be displayed on a pie (circle) graph. b. Not realize that the same data can be shown on different types of graphs. c. Believe that all graphs present “true” things, i.e. not realize that data can be manipulated to communicate different messages. d. Not realize that some information can be better represented on a specific type of graph. 4. Students may... <ol style="list-style-type: none"> a. Misinterpret data, including notation, scale, etc. b. Confuse graph types.

	<p>c. Not pay attention to the axes of the graphs. For example, one graph shows percentages and students may read the information as 40 students instead of 40% of students.</p>
<ol style="list-style-type: none"> 1. What are your expectations for students as they work on and complete this task? 2. What resources or tools will students have to use in their work? 3. How will the students work -- independently, in small groups, or in pairs -- to explore this task? 4. How long will they work individually or in small groups/pairs? 5. Will students be partnered in a specific way? If so, in what way? 6. How will students record and report their work? 	<ol style="list-style-type: none"> 1. Students will work in various situations and discuss what their graphs are telling them. They will compare the different types of graphs and eventually explain which graphs would be appropriate in which situations. 2. Students will have a worksheet and graphs (provided by us). They will have pencils to answer and reflect on the questions. 3. Students will transition from independent think time, to a jigsaw activity where they will work in big groups and then break up into groups of 3. 4. They will work individually for 10 minutes, in expert groups for 10 5-7 minutes, and then in small groups for 20 minutes. 5. Expert groups will be based on which graph students are given. We will form groups so that we have multiple, smaller expert groups for each graph instead of just one large one group. Small groups will be formed so that the three people are all from different expert groups. Therefore each type of graph will be represented. In some cases, two students with the same graph will be put in the same group in order to progress the activity in a beneficial way. 6. Work will be recorded on the worksheet provided to them and in their notebooks.
<p>How will you introduce students to the activity so as to set high expectations, maintain the cognitive demand of the task?</p>	<p>We will stress that the main part of the task is to explain their mathematical thinking. The point is to determine what they can and come up with reasons why a graph is appropriate.</p>
<p>What will you hear that lets you know students understand the task?</p>	<p>We will ask for a student or two to repeat the instructions. If they are able to clearly explain what they are expected to do, then we will know that they understand the task.</p>

Part 1: Lesson LAUNCH Script

The launch of a lesson or a task is important because it sets up the mathematics and the tone for the whole class period. Use this space to plan/script exactly what you plan to say to launch the lesson or task.

Also use this space to anticipate what you expect to hear from students. What are the questions they might have about the task? How will you respond to those questions?

Today we will be talking a lot about graphs. Can someone tell me where they have seen graphs before? (*Newspapers, math class, TV, science class, online*). What are some different types of graphs you have seen? (*Line, bar, pie (circle), scatter - write all suggestions on the board*). So, who uses these graphs and how? (*Journalists to tell a story, media to show statistics or increasing and decreasing quantities, students to do their homework*). Very good! So graphs communicate a lot of information and *different types* of graphs communicate *different types* of information. Today, we will be exploring three different types of graphs - line graphs, pie (circle) graphs, and bar graphs. Some graphs represent certain sets of data more accurately than other graphs. We will figure out what the best graph for certain data is based on what the graph communicates to its readers.

Launch individual work time: To start, we have these three types of graphs with information about students at Eastern. You will have 10 minutes (set a timer on board) to look at your graph and answer the questions. After 10 minutes, we will let you talk with other students in the class with the same graph and compare your answers. Can someone repeat what you will be doing? Do you have any questions? (*Distribute graphs and question cards in such a way that it is easy for the bar graphs to group together-same for pie and line graphs- after individual work time*).

Launch expert group work time: Now you will get into groups with other students who had the same graph as you did. Take a few moments to share your work, making sure you can talk about all aspects of your graph. Then, as a group, decide what story your graph tells and what evidence from the graph helps tell the story.

Launch group work time: Now that you have become an expert at your type of graph, we are going to put you into groups of three (*or four if the class is not divisible by three*) so that each group has at least one of each type

	<p>of graph. Once you're in your group, take a few minutes to explain the story of your graph to your group. Remember you are the expert on your graph, so make sure you answer any questions your group members might have about your graph. <i>(Group students and allow them discussion time. Answer any remaining questions groups have)</i></p> <p>Now that you know a little bit about all three graph types, you are going to work as a group to look at this new data and decide which type of graph would most accurately represent this information. Once you decide which graph to use, create that graph and write an explanation for why you chose to use that graph type. Can anyone tell me what you're doing in your group? Does anyone have any questions?</p> <p>Launch of extra task (if time): Take a look at this graph. What does it communicate? What about this graph <i>(show the same graph that is skewed to communicate different information)</i>? What is the same and different about this graph? <i>(Students may identify that it has the same title, but the bars are different heights. Students may recognize that it is showing the same data- if they don't, then point out that surprisingly this is made from the same data!)</i> Sometimes the media doesn't like to show the information accurately but wants the graph to show a certain aspect more drastically. Has anyone noticed this- where have you seen it? <i>(Students may remark on times they have seen it, or ask questions clarifying what was said)</i>. As a group, look back at the graph you just made. Choose something you would like to try to communicate and think of ways you can change your graph (using the same data!!) to make it communicate different information.</p>
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Part 2: Supporting Students' EXPLORATION of the Task	
As students are working independently or in small groups:	<p>1.) We will ask:</p> <ul style="list-style-type: none"> ● What facts can you learn from your graph?

<p>1. What questions will you ask to focus their thinking?</p>	<ul style="list-style-type: none"> ● What other things do you notice about the graph? ● What does the title tell you about the graph? Would you be able to make sense of it without a title? ● Do the heights of the bars matter in the bar graph? (modify - does the size of the wedge of the pie graph? Does the slope of the line matter in the line graph?) How?
<p>2. What will you see or hear that lets you know how students are thinking about the mathematical ideas?</p>	<p>2. We will see students talking together, referencing the graphs as they do. They will be saying things like</p> <ul style="list-style-type: none"> ● “That data couldn’t be put into a pie graph because...” ● “This needs to be a bar graph because...” ● “I agree that the graph communicates ____, but doesn’t it also communicate ____?” ● “The information in the graph is surprising/expected/relevant to me as a student at Eastern because ...” ● “I never saw this information before - I wonder if this data is here because ...”
<p>3. What questions will you ask to assess students’ understanding of key mathematical ideas, problem solving strategies, or the representations?</p>	<p>3. To assess, we will ask:</p> <ul style="list-style-type: none"> ● “How did you determine that this was what the graph communicated?” ● “Does this new graph communicate the same information? Does it use the same data as the first graph?” ● “How did you obtain the data from this graph?” ● “What other information did you use to determine what the graph communicates?” ● “What sort of information is communicated by your <i>type</i> of graph?”
<p>4. What questions will you ask to advance students’ understanding of the mathematical ideas?</p>	<p>4. To advance understanding:</p> <ul style="list-style-type: none"> ● “What could you change about the graph that would communicate different information?” ● “What types of things can we change about the graph that won’t change the actual data used to create the graph?” ● “If a newspaper were to use this graph in an article, what do you think the article would be about?” ● “Do you think this is the “best” way to represent the data?”

<p>5. What questions will you ask to encourage students to share their thinking with others or to assess their understanding of their peer's ideas?</p>	<p>5. To encourage sharing:</p> <ul style="list-style-type: none"> ● “Did the rest of your group agree or disagree with what the graph communicated? Why do you think they thought that way?” ● <i>Ask a student who originally had a bar graph what information his peer with the pie graph communicated to him (ask about a graph they didn't have).</i> ● “What did ____ say about line graphs? Do you agree? Do you have anything to add to their explanation that they did not talk about?” ● Think, pair, share to generate responses from a quiet class.
<ol style="list-style-type: none"> 1. How will you ensure that students remain engaged in the task? 2. What will you do if a student does not know how to begin to solve the task? 3. What will you do if a student finishes the task almost immediately and becomes bored or disruptive? 4. What will you do if students focus on non-mathematical aspects of the activity (e.g., spend most of their time making a beautiful poster of their work)? 	<ol style="list-style-type: none"> 1. Because of the nature of the students that we work with, we know it is hard to keep them on task. This had led us to make multiple portions of the task. They will be moving from individual work, to big group work, to small groups. We are not expecting them to work on any one portion for too long at a time. 2. The point of this task is to encourage thought. If a student says they do not know where to begin, we will encourage them to write down whatever they can think of, even if it is just one piece of information. 3. We plan to have an extra thought to pose if we have more time at the end which we can give to groups who finish early. 4. We will focus the students by asking them if they have reasoned through all of the questions posed. If they have, then they should be able to argue multiple points to us.

Part 4: Sharing and Discussing the Task (LESSON SUMMARY)

<p>How will you orchestrate the class discussion so that you accomplish the mathematical goals of the lesson? Specifically:</p> <ol style="list-style-type: none"> 1. Which solution paths do you want to have shared during the class discussion? In 	<ol style="list-style-type: none"> 1. Solutions to be shared - make sure to have at least one student from each of the three graph types share information about what their graph communicates and what it means to them as a student at Eastern. Specifically, we will ask someone who did not start with a certain graph to explain it, allowing us to assess the discussions that occurred in the expert groups.
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<p>what order will the solutions be presented? Why?</p> <ol style="list-style-type: none">2. In what ways will the order in which solutions are presented help develop students' understanding of the mathematical ideas that are the focus of your lesson?3. What specific questions will you ask so that students will:<ol style="list-style-type: none">a. Make sense of the mathematical ideas that you want them to learn?b. Expand on, debate, and question the solutions being shared?c. Make connections between the different strategies that are presented?d. Look for patterns?e. Begin to form generalizations?	<p>Also, if any of the groups had difficulty interpreting information on the graphs, then present those difficulties to the whole class. After the group part of the task, be sure to compare the different types of graphs constructed and discuss which one most accurately depicts the given information. The information will be presented like this because the task is too open ended to give every student a chance to share in whole class, but it is important to discuss each type of graph and what situations (i.e. what data) are appropriate for that type of graph. We will also make sure to discuss the strengths and weaknesses of each type of graph, as well as the contexts in which they are used.</p> <ol style="list-style-type: none">2. Since the order is open, the order presented will not help develop understanding. Perhaps doing pie graphs last would help because those are the only graphs we have not seen them work with in class.3. Questions:<ol style="list-style-type: none">a. "In general, what type of data can be made into a pie/bar/line graph?", "What aspects of the graph play a role in the information that the graph communicates?"b. "Can you <i>always</i> make a different type of graph from the same data? If not, in what situations?", "Did everyone think the graph communicated this information?"c. "Are there any aspects of the graphs that are the same or similar? Which aspects are different?"d. "What patterns do you see across the different types of graphs?"e. See part a. Also, "How does the graph type affect what the graph communicates?" <p>Note: If students are being quiet and having trouble coming up with thoughts, we will give them time to "think-pair-share".</p>
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<p>What will you see or hear that lets you know that students in the class understand the mathematical ideas that you intended for them to learn?</p>	<p>Students will...</p> <ul style="list-style-type: none">● Explain the applications of basic types of graphs and the differences between them, such as what types of data can be conveyed on each.● Students will be able to construct an appropriate graph from the data given.● Generate appropriate “stories” for given graphs and explain their significance.
<p>What will you do in following lessons that will build on this lesson?</p>	<p>Relating to our follow-up extra section on manipulating graphs to convey different messages, their textbook has a short lesson on this topic, and we would like to see the students become more informed on how to identify this manipulation in order to better understand the messages being presented by media, government, and other information sources.</p>