Monopoly Graphs
Lesson Plan

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Grade/Class: 8th Grade Math
KY Standards:
MA-08-1.4.1: ratios and proportional reasoning
MA-08-4.1.1: analyze and infer from data displays
MA-08-4.1.4: construct & explain appropriate data displays

Objectives:

Students will gain familiarity with the process of generating visual representations of raw data, and interpreting that data into strategic guidelines.

Resources/Materials needed:

One set of deed cards from Monopoly, or a Monopoly-like board game
One copy of the handout at the end of this document for each student

Motivation:

My experiences as an instructor of the introductory Biology labs at the University of Kentucky have given me a first-hand awareness of the problems that students have generating appropriate visual representations of data, even beyond the High School level. This lesson, pitched to an eighth-grade level, seeks to illustrate the investigative and illustrative power of visual representations of data. The lesson centers on a data set from the board game Monopoly, which many of the students should have already encountered. I hope that constructing the lesson in this manner will both decrease student fear, stress, and resistance to the content by associating it with fun leisure activities. Further, I hope to spark student enthusiasm for the content by appealing to the student's competitive spirit, as participation in the lesson should markedly increase future student performance at playing Monopoly.

Prior Knowledge:

This lesson targets an eighth grade audience, and assumes prior exposure to the concept of graphing and to x/y tables. Full student participation in the lesson requires no further prior mathematic experience or experience with the Monopoly board game. The lesson plan presumes that the instructor has played Monopoly.

Lesson Source:

The data set used in this lesson comes from the board game Monopoly, all game mechanics of which have passed into the public domain. Other than the data set, this lesson plan and all accompanying content represent completely original work.

Mode of Instruction:

lecture discussion, with student graphing, both on the board and on the handout

Estimated Time:

This lesson should completely fill one eighty-minute class period.

Date Submitted:

7/2/9

Lecture Notes:

This lesson uses the deed cards for the Monopoly game properties Baltic Avenue, Connecticut Avenue, Virginia Avenue, New York Avenue, Illinois Avenue, Marvin Gardens, Pennsylvania Avenue, and Boardwalk. If you're using a nontraditional Monopoly set, these are the most expensive properties in each of the color groups except for the dark purples. Divide the class up in to seven groups, and give each group one of the deed cards, keeping Boardwalk for yourself. Also give a copy of the handout (the last two pages of this document) to every student.

Today we get to improve our skills at Monopoly. It's a complicated game, and, because of that, optimal Monopoly strategy is also complicated. But, by doing some data analysis we can learn some important guidelines to significantly improve our chances of winning. We're going to make pictures of our data, and there are some cases where what the pictures suggest good strategies, but there are other cases where the pictures fail to take something important into account. We'll talk about those cases as they come up, because it's important to understand both how valuable a picture of data can be, and how deceptive it can be if you don't read it in the proper context.

The game includes eight different monopolies, two on each of the four sides of the board. Each monopoly has an assigned color, and that's how we'll refer to them. The colors, in order of appearance around the board, and in order of expense, are dark purple, light blue, light purple, orange, red, yellow, green and dark blue. Each of your groups has the most expensive property of one color, and every group has a different color. Now, in the game, one of the most important goals to meet is to get a whole monopoly. That means acquiring every property in a color group, either by buying them from the bank or by trading for them with other players. Without the whole monopoly, you can't build any houses on the properties, and building houses is the key to getting money from the other players. So, one of the most important pieces of information for you to walk away from this lesson with is which monopolies are better than the others.

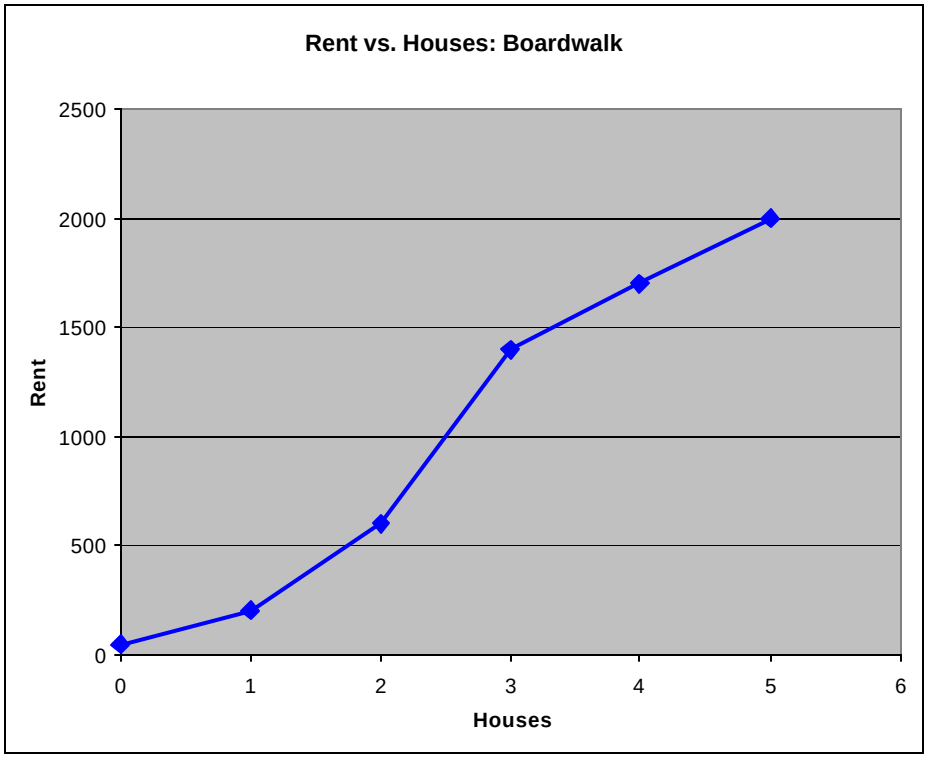
In this class and previous classes you've turned x-y tables into graphs by plotting points and connecting the dots you plot. Each of you will do this with the data from your group's deed card. I'm going to use the deed for Boardwalk as our example. For our first table and graph, our x column will represent the number of houses that the player has built on the property. Our y column will show how much money another player has to pay the owner of the property if they land on it. Now, as I fill out my x-y table for Boardwalk, you should fill out the table on your hand out. Don't use my data. Use the data from the deed card for your group. I'm going to use 5 houses in the place of hotels, but if that bothers you, you can write the letter H in the bottom of the x column instead of the number 5.

Copy the following table on to the board:

Houses:	Rent:
0	50
1	200
2	600
3	1400
4	1700
5	2000

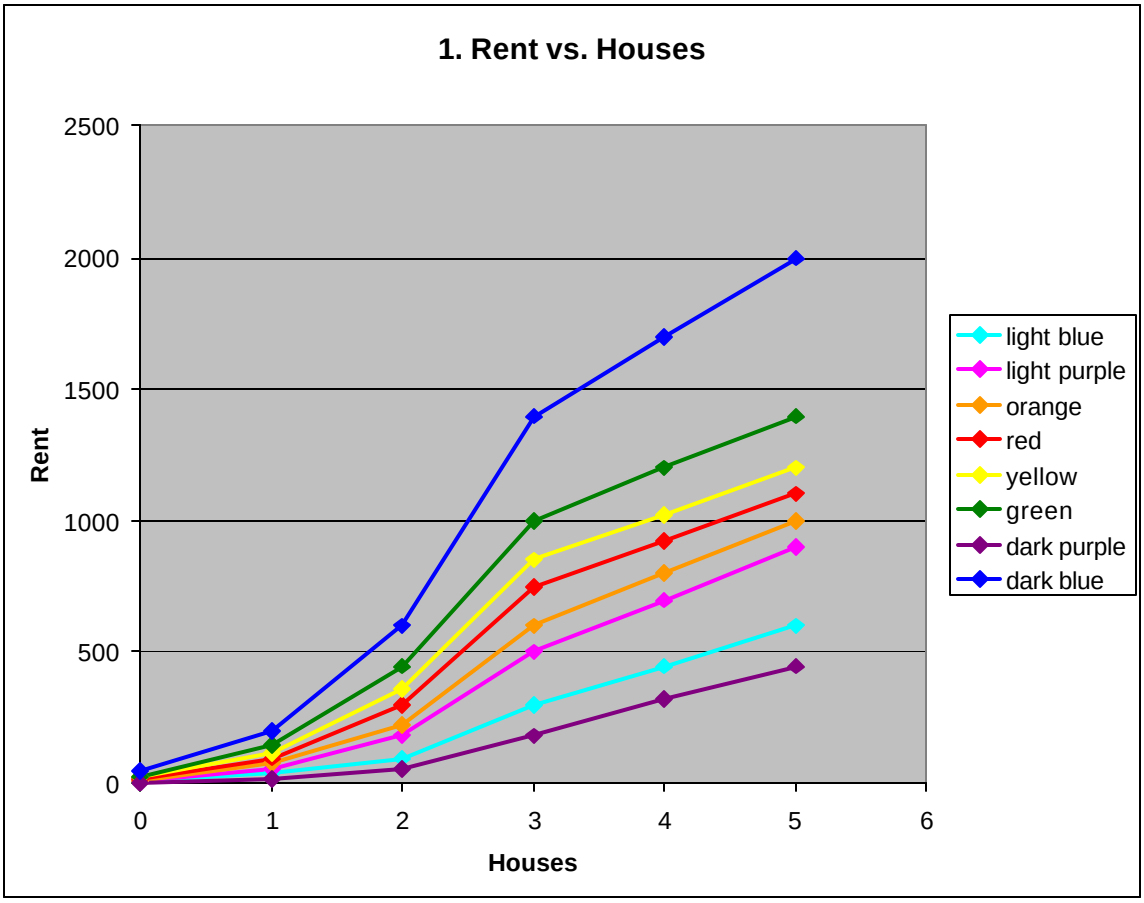
Now, I'm going to make a graph of this data. As we work on making this graph, you can work on making the first graph of your data on your paper.

Graph the data from the table on the board. Make your graph as large as possible so that students can graph their data on the same axes. Get the students to tell you what to label the axes, and why. Get them to explain what the biggest number on the y axis should be, and why. Because the data comes from Boardwalk, the most expensive, highest rent property in the game, no y values above its maximum of 2000 will occur. The graph should look a lot like this:



Now, as you finish making the graphs of your own data on your paper, I need a volunteer from each group to come add their line to the big graph up front.

Supervise the process. To the greatest extent possible given your available color options, use colored lines that match the Monopoly colors. Dashed dark blue can serve as light blue; red dashes interspersed with blue dashes can serve as a purple. As the process progresses, narrate the additions to your class-wide master graph and discuss any errors or complications. After every group has contributed, the graph should closely resemble this one:



So, now, we have a picture of how much rent each property earns compared to how many houses are on it.

Lead a conversation with the class on what this graph does and does not show. One important point is how every line is steeper between 2 and 3 houses than between any two other points. Exploiting this is critical to effective Monopoly play. When you get a monopoly, you should work hard to get all of the properties in that monopoly to three houses, even if that means mortgaging other properties. If you have two monopolies, get the better one (which monopolies are better will be discussed below) up to three houses on every property, then switch to spending resources on developing the second monopoly. As a general rule, don't add a fourth house to any property until all the properties in all of your complete monopolies have three houses. If you need to sell off houses to pay off debt, keep three houses on your best properties as long as possible, even if that means mortgaging other properties.

Ask the students what the graph says about which monopoly is best. When they suggest that the dark blues (including Boardwalk) are best because they're on top, admit that the while the dark blues do happen to be really good, this graph actually doesn't say anything at all about which monopolies are best. The lines on this graph are higher if the properties pay out more in rent, but it completely fails to take into account how much the player has to spend in order to be able to charge that much rent, so the lines simply get higher as the properties progress around the board. Use this as a lead in to Graph 2.

Most of the time, during a game of Monopoly, players will get to a point where all of the properties from more than one monopoly have been bought, but nobody has a monopoly yet. At that stage, what you should try to do is trade with the other players to get a monopoly. The other players will usually not trade with you unless they get a monopoly out of the deal too. So, it's very useful in this sort of situation to know which monopoly you should try to get for yourself, and which monopoly you'll be willing to trade away to get what you want. So, now we're going to make a new graph, one that will help us evaluate which monopolies we should try to get. The last graph showed us some useful information, but it failed to include how much money a player has to spend in order to get the rent levels that we graphed. So, this time, we're going to include that expense.

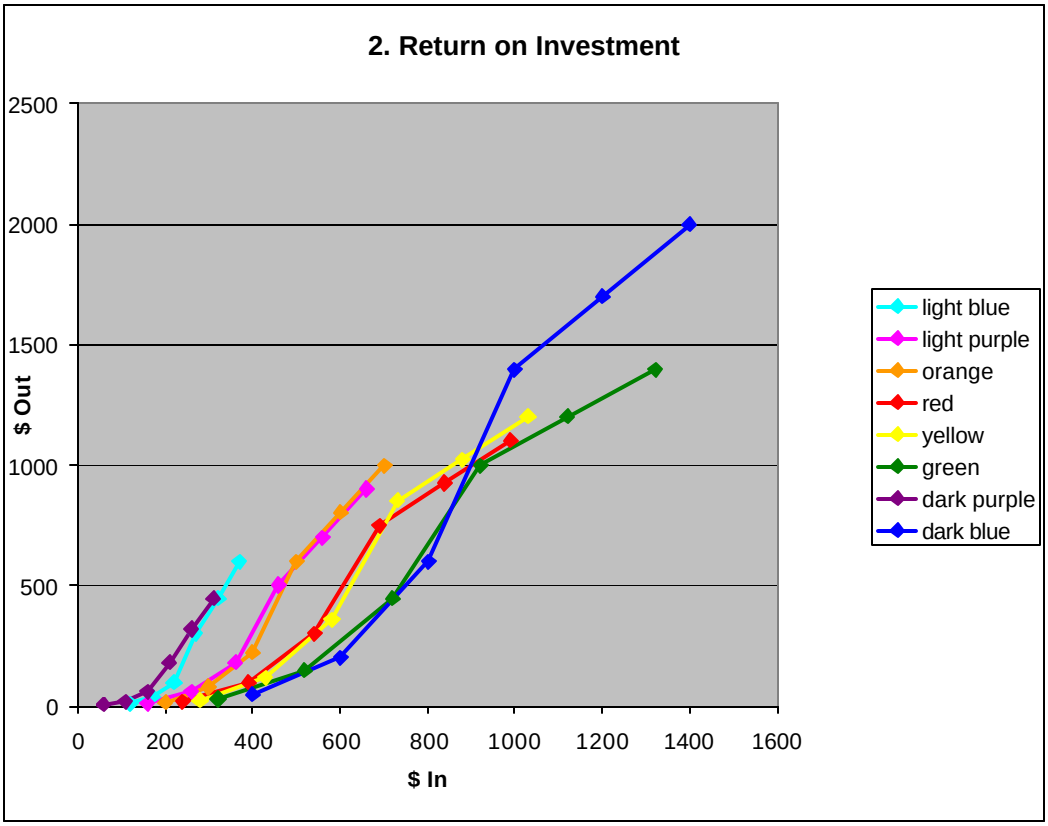
Again, we're graphing in 2 dimensions, on an x/y coordinate plane. We want our x-axis to represent our independent variable, and our y-axis to represent our dependant variable. What we want to show is how the money we can take in as rent changes as we increase our investment in the property. So which variable depends on the other, which one is affected by our manipulations? Rent out depends on investment in, so rent represents our dependant variable, and investment represents our independent variable. By convention, we plot independent variables along the x-axis, and independent variables along the y-axis, so, here, we'll put investment on the x and rent on the y.

Again, you're going to use your group's deed card as the source of your data rent data. You can go ahead and copy those numbers down into the Rent column of the x/y table on your worksheet. For investment column, you need to know two things, how much it cost to buy the property, and how much it cost to buy each house. The deed card you have does not list the cost of the property, but, in Monopoly, properties have a mortgage value that's half the cost. So, double the mortgage value that's listed on your card and you'll get the cost for your property. And put that value into the top cell of the investment column of your x/y table, because the cost of the property is the investment cost to get the property up to zero houses. To fill out the rest of the table, you need to know how much each house costs, and that depends on which monopoly you've got. Houses on dark purple and light blue properties cost $50 each. Houses on light purple and orange properties cost $100 each. Houses on red and yellow properties cost $150 each. Houses on green and dark blue properties cost $200 each. So, the second cell of the Investment column of your x/y table should be the cost of the property from the first cell, plus the cost of one house. The third cell should be the value in the second cell plus the cost of another house, and so on. Fill your tables, then draw your graphs, and while you're doing that, I'll put my data for Boardwalk on a big graph up front.

The Boardwalk data table follows:

$ In	Rent Out
400	50
600	200
800	600
1000	1400
1200	1700
1400	2000

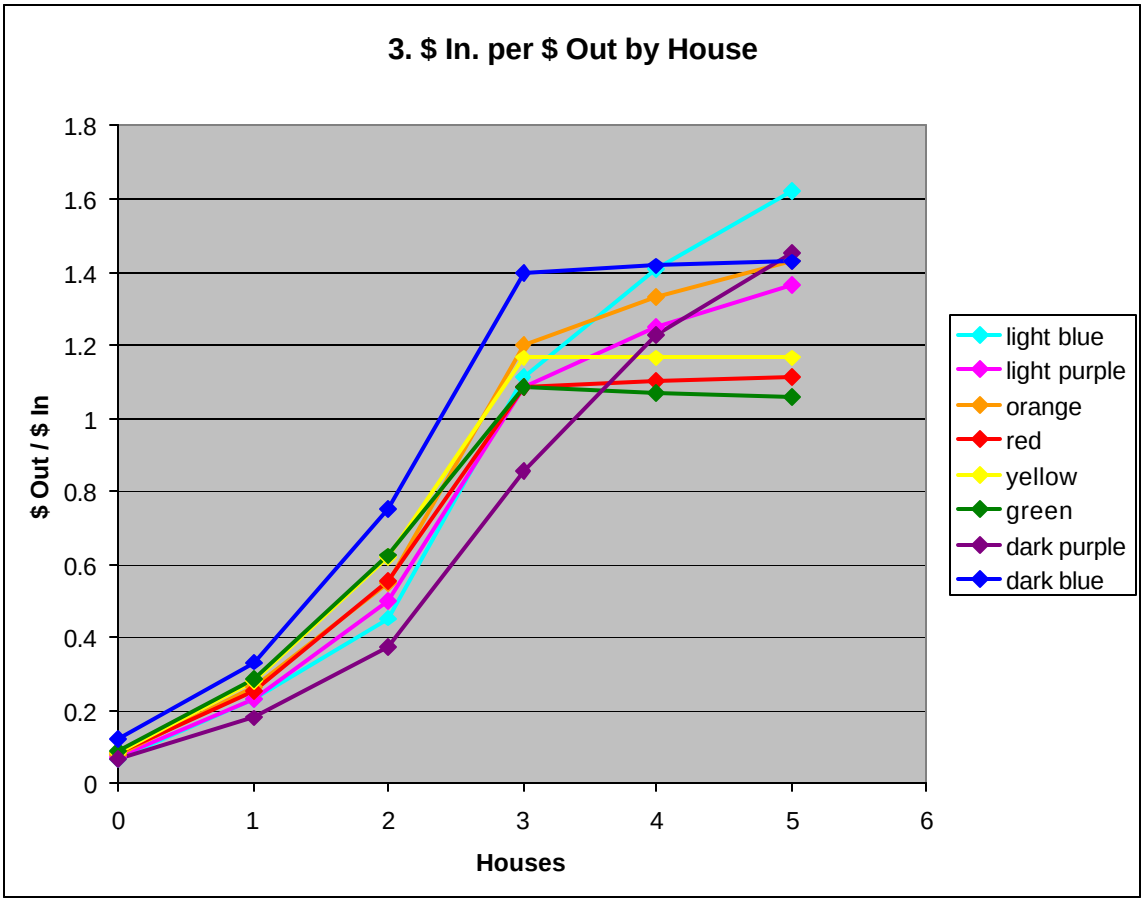
When they're ready, have one member of each group (a different member from the one who came up for graph #1) come add their lines to your master graph. The result should closely resemble this graph:



We now have a picture of the relationship between investment in and rent out, separated by the various monopolies. Now, we want to make one more graph. The player wants the most rent dollars out for the least investment dollars put in. To find this, we divide rent by investment and get a return on Investment ratio. Do this for each cell in the Rent/Investment column of your last x/y table. Take the rent value from the second x/y table, divide by the investment value from that same table, and put the value in the blank.

Again, draw the Boardwalk line on a fresh graph on the board, then invite students to come up and add their lines as they finish. The data table for boardwalk follows, and the assembled result should closely resemble the subsequent graph.

Houses:	$ Out / $ In
0	0.125
1	0.333333
2	0.75
3	1.4
4	1.416667
5	1.428571



Close by leading the final conversation about what this graph does and does not show.

Note the point at three houses where most of the curves start to plateau, and all of the curves get less steep. As we've already discussed, this is the point, three houses, you should try to get (and keep) your properties developed up to. Also note that the most dollars out for each dollar in of any of the monopolies is the light blue with five houses, which is even better than Boardwalk. In order to think about that in the proper context, though, we need to look back at Graph 2. Note how the light blue line in Graph 2 stays in the lower left corner of the graph. This reflects how inexpensive the light blues are relative to the other properties, and while their $ out / $ in ratio is the strongest, in absolute dollar terms, they do not generate nearly as much rent. This makes them an ideal first monopoly. Early in the game, before players have accumulated much wealth, developing the light blues remains affordable, and can provide a powerful revenue stream with which to develop other, more expensive monopolies, with a weaker $ out / $ in but larger rents.

For the following portion of the discussion, bring up an image of the monopoly game board.

A final consideration about the value of these graphs comes when you take into account how often any given property gets landed on. Many of the Chance and Community Chest cards move the player, and, more importantly, players frequently get sent to jail. Because of this, the monopolies just past the jail, particularly the orange properties get landed on more frequently than other properties, and therefore have more value in the game than the above graphs can show.

Handout: Graphing the Monopoly Data Set

Table 1: Fill in the table from your group's deed card, then graph the relationship for your property:

Houses:	Rent:
1	
2	
3	
4	
5	
H	

Table 2: The Rent column of the second table also comes from your group's deed card. The investment Column represents how much a player must spend on this property for it to yield the rent listed. The first cell under Investment should show the purchase price of the property, as listed on the deed card. The second cell should show the purchase price plus the price of one house; the third cell should show the purchase price plus the price of two houses, and so on. Houses on dark purple and light blue properties cost $50 each. Houses on light purple and orange properties cost $100 each. Houses on red and yellow properties cost $150 each. Houses on green and dark blue properties cost $200 each. Fill in the table for your property, then graph the results.

Investment:	Rent:

Table 3: For the final table, the y-axis column consists of the rent column from the previous graph divided by the investment column from the previous graph. Fill the table, and graph the results.

Houses:	Rent/Investment:
1	
2	
3	
4	
5	
H	

The first person from each group to finish filling all three tables and graphing all three lines above should come to the board and add their line from Graph 1, above, to the class Graph 1. The second person to finish should add their Graph 2 line to the class Graph 2, and the third person should add their Graph 3 line to the class Graph 3.