

Interpretation of Graphs

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Third Grade Lessons

1. **How Many Points?** - Students work with: (a) a context — distance as a function of time; (b) generating coordinates.
2. **Human Graph I** - Students plot themselves on a Cartesian plane. Each student will get a large card with a place for an ordered pair: (x, y) , where x refers to hours worked, and y refers to amount earned. The students must name the coordinate pair for the point they themselves are standing on.
3. **Human Graph II** - Students graph the functions $k \times 2$ \$/h and $k \times 3$ \$/h. The idea is to show that for each linear function the points fall onto a straight line.
4. **Interpreting Graphs** - Students will be given two linear distance-time graphs and asked to tell a story about each graph and to compare them. They will later explore comparisons between points in each line.
5. **Maps to Graphs** - Students will be given two linear distance-time graphs and asked to tell a story about each graph and to compare them. They will later explore comparisons between points in each line.
6. **Rates vs Totals** - Students compare points on an hours/pay Cartesian space. The main challenge lies in recognizing that, although one student earned more, the other student was paid better, that is, at a higher rate of pay. They must indicate the difference in pay and the differences in amount worked.

Fourth Grade Lessons

1. **Cartesian Candy Bars I** - We compare ratios of various ordered pairs in a Cartesian grid. The initial discussion concerns the space as a whole; the task will focus on selected points and on the ratio of the dependent variable to the independent variable.
2. **Cartesian Candy Bars II** - Children work on sharing different amounts of candy bars among different numbers of people. They compare ratios (candy bars per person) and plot points in a Cartesian grid.
3. **Comparing Functions** - This lesson is split into two days. In the first class, the students will analyze eight basic graph shapes and will represent and solve a verbal problem involving the choice between two functions. In the second one they will be asked to choose, among the eight basic graph shapes, the ones that matches specific situations.
4. **Equations and Inequalities** - Students will work with equations and inequalities, first with simple ones and later with comparisons of two functions. The Wallet Problem, introduced in a previous lesson, will provide the background context.
5. **Evaluation Problem** - Students will be given a problem that asks about the amount of money each person has, based on the amount in a piggy bank. They will be given one graph and asked to draw the second graph.
6. **Fourth Grade Assessment III** - This is a written assessment where children will be asked to interpret graphs and to interpret and determine the truth or falsehood of equations and statements that describe comparisons between quantities.
7. **Fourth Grade Assessment IV** - This is a written assessment where children will compare two students. One of the students' speed can be represented linearly while the other's speed is represented by a non-linear graph.
8. **Graphing A Story** - A trip is described in miles, hours, and miles/hr. Students produce a graph from the description. They then produce a table from the graph and answer questions about the trip.
9. **Intervals** - Students reason about graphs showing growth over time. They compare heights of children and heights of two animals at different time intervals.
10. **Multiplicative Candy Boxes II** - This class is a continuation of the Multiplicative Candy Boxes I lesson. It centers on the possible amounts of candies two children, Juan and Marcia, have. Juan has a box of candy and Marcia has twice as much candy. What are the possible amounts of candies they might have?
11. **Running Race I** - Compare a race between two students: one who runs at a constant pace, the other who tires out as the race proceeds.
12. **Running Race II** - Compare a race between two students: one who runs at a constant pace and one who changes pace as the race proceeds.
13. **Swimming Pools I** - Compare how two swimming pools fill up with water over several hours.
14. **Swimming Pools II** - Students will examine the rate of pools filling over several hours.
15. **The Better Paying Job I** - Children work on a problem about rate of pay per hour of work. They compare ratios (dollars earned per hour of work) and discuss and plot points in a Cartesian plane.
16. **The Better Paying Job II** - Children work on a problem about rate of pay per hour of work. They compare ratios (dollars earned per hour of work) and discuss and plot points in a Cartesian plane.
17. **Three Heights Review** - In this class we will explore: (a) How children deal with comparisons, (b) How they draw inferences from comparisons, and (c) How they represent comparisons between three unknown amounts.
18. **Two Phone Plans II** - Students will work on the comparison between two phone plans (also used in the lesson "Two Phone Plans I"), one of which has a lower rate, but a monthly basic charge, the other has a higher rate but no basic charge.
19. **Varying Speed** - Children are asked to tell a story about a trip depicted through a graph that has varying slopes/speeds.
20. **Varying Velocity** - Children are asked to tell a story about a trip depicted through a graph that has varying slopes/velocities.
21. **Wallet Problem III** - Students will continue working with the wallet problem. They will be shown a graph for Mike's amounts and asked to (a) determine whether it represents Robin's or Mike's money and (b) to predict where the line for Mike would fall. Later they will plot Mike's amounts and will discuss why the lines cross.

Fifth Grade Lessons

1. **Basic Function Shapes** - In this lesson, the students will (a) discuss, represent, and solve a verbal problem involving the choice between two functions; (b) choose, among 8 basic graphs (7 distinct shapes), the one that matches specific situations; and (c) write stories to match a specific graph shape.
2. **Equations and Graphs** - Students will further compare two linear functions in the context of evaluating two plans for shoveling snow. One plan has two parts: a basic charge plus a charge based on the number of square meters cleared. The other plan has no basic charge; it only charges according to the number of square meters cleared. However the per-meter charge is higher than in the other plan. Students are asked to determine the circumstances in which the bill from each plan would be the same. They then examine the graph of the two functions and discuss how equations and inequalities relate to the graph.
3. **Fifth Grade Assessment III** - This assessment will focus on writing equations to solve verbal problems and on solving equations using the syntactic rules of algebra.
4. **Phone Plans** - Students will compare two linear functions in the context of evaluating phone plans. One plan has two parts: a basic charge plus a charge based upon the number of minutes used. The other plan has no basic charge; it only charges according to the minutes used. However the

per-minute charge is higher than in the other plan. Students are asked to determine the circumstances in which the monthly bill from each plan would be the same. They then examine the graph of the two functions and discuss how equations and inequalities relate to the graph.

5. **Review on Graphs and Equations** - In this lesson, the students will solve individually or in small groups the set of problems. For each problem, the teacher will lead a discussion based on the students' work (the teacher should identify strong and weak points in the students' work). The class is organized around four main problems. Within each problem students will answer different questions.
6. **Train Crash** - Students will compare two linear functions represented in a graph. They reason about the problem using (a) the word problem and two diagrams; (b) a graph of position vs. time; (c) a table of values (d) making expressions for each position function; and (e) solving the equation algebraically.
7. **Varying Rates of Change** - Students will compare three functions, two of which are nonlinear, that tell the story of three cousins who all save \$1,000 in one year. One saves a lot the first day and less and less each day as time goes on; one saves very little the first day and more and more each day throughout the year; the last cousin saves the same amount each day. Students will be asked to predict the shape of the graph for each function and, later, to look at and describe graphs of all three cousins' savings.
8. **Wallet Review Problem** - This activity is a review of the Wallet Problem done in fourth grade. It is intended to introduce new students to some of the concepts we have covered and to refresh the memories of our old students. Students compare the amounts of money two students have. The amounts are described relationally but not through specific dollar amounts.

Middle School Lessons

1. **Box Extremum** - Students will start by finding average rates of change for a non-linear function over increments of the independent variable. The size of the increments will decrease to introduce the idea of using tangent lines to find instantaneous rates of change of linear and non-linear functions. Students will see what a tangent looks like at the extrema of a graph. Students will then create a box that maximizes the volume and see how determining the extrema of a graph can help to find the maximum volume.
2. **Graphing Equations** - Students will practice moving between graphs and equations of functions, as well as identifying the y-intercept and slope.
3. **Guess My Rule - Linear** - Students will try to determine the equation to match their partner's created graph and work together to correct their own mistakes.
4. **Guess My Rule - Non-Linear** - Students will produce algebraic expressions starting from non-linear graphs produced by other students in the class.
5. **Race Car Activity** - Students will look at four different graphs to determine which two describe the scenario proposed by the teacher displaying parallel lines and the correct y-intercepts.
6. **Relating Graphs and Equations - Linear and Quadratic Functions** - Students will generate graphs from given equations and equations from given graphs.
7. **Who Shares My Function? - Linear with All Representations** - Students will work in groups after finding other students who have the same linear function represented by a story, a table, a graph, or an equation. They will attempt to explain and discuss why the different representations refer to the same function.
8. **Who Shares My Function? - Linear with Graphs and Stories** - Students will make groups by finding other students who have the same quadratic or linear function in different representations.
9. **Who Shares My Function? - Linear with Graphs, Tables, and Equations** - Students will make groups by finding other students who have the same linear function, as shown in representations of graphs, tables, or equations. They will then generate a story to go with the function.
10. **Who Shares My Function? - Linear with Negative and Fractional Slope** - Students will find other functions that are the same as theirs, starting from a table, a graph, or an equation. Once they have identified the same function represented in a different way, they will create a story that describes all of the different representations of the same function.
11. **Who Shares My Function? - Quadratics** - Students will make groups by finding other students who have the same quadratic or linear function in different representations.