Subways - Lesson 4 - Linear equations - TD

Lesson Overview
The Riverville map that students made shows the express stops. But Riverville has the budget to also add three local stations. Local stations must be on the same line, between two express stations. Students will choose prime locations on their maps for a local station. These could be a closer stop to a museum or school. Then they will then use the linear equation \((y = mx + b)\) in the process of modifying their maps and locating the precise coordinates for their new local stations.

This is the starter map. Load this file onto student iPads as it is the correct aspect ratio. Students will see the map image in Choreo Graph and then create a subway map with this as the background. (Students can also use the subway map that they already designed from Lesson 1.)

One unit on the grid in Choreo Graph = \(\frac{1}{4}\) mile = .25 mile
**Linear equations**

In this example, we show how to calculate slope, find y-intercept and then express the equation of the line between two points at Jones and Fitzgerald. Then we use that equation to find a local station that is a point on that line.

This is a screenshot that shows the translation line and coordinates in Choreo Graph for Jones and Fitzgerald.
This image shows work in finding slope, then plugging in the coordinates for Jones (5, -8) to solve for b, the y-intercept.

Slope: \[ \frac{y_2 - y_1}{x_2 - x_1} = \frac{-13 - (-8)}{2 - 5} = \frac{-5}{19} \]

\[ y = -\frac{5}{19} x + b \]

\[ -8 = \frac{5}{19} (5) + b \]

\[ -8 = \frac{25}{19} + b \]

\[ -\frac{152}{19} - \frac{25}{19} = b = -\frac{177}{19} \approx -9.32 \]
Once we have slope (m) and the y-intercept (b) we have our equation, shown here. We might choose our local station to have x-coordinate of 10, then we can plug that into the equation to find y, and that results in the (x, y) coordinates for the new local station.
Learning Objectives:

<table>
<thead>
<tr>
<th>Linear Equations</th>
<th>Activity: Students will add three new local stations to their map, and will need to find linear equations in the form y = mx + b to show that each local station is indeed on the line between two given express stations.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Objective: SWBAT use linear equations to analyze their subway map.</td>
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</table>

What you need to get started: Set of iPads with the Choreo Graph app, student sheets

Time Needed: 1-2 class periods

Collaboration and Group Work
These lessons are designed for students to work individually, in pairs, or in groups. Each student should do all the work on their own sheets, and the iPad should be shared across group members as equally as possible.

We suggest that groups be no larger than four students. Four or more students in a group will require extra attention to make sure that every group member is contributing equally.

Lesson Plan
Introduction
1) Discuss and/or review linear equations with students. This lesson focuses on slope-intercept form, y = mx + b, so be sure they are familiar with that.
2) Provide the example above if that would be a helpful.
3) Have students help you find the equation of a line between two points, leave the example on the board.

To do
1) Students will follow the instructions on their sheets.
2) The lesson guides students through an example like the one above.
3) Circulate the room and check for understanding, help students as needed.

Sharing
1) With each lesson, spend some time allowing the students to share their work with the class. In this lesson, students can share difficulties they might be having as well as successes in finding slopes, y-intercepts, linear equations and local station coordinates.
2) You might also invite students to continue thinking about how local stations enhance the city for subway passengers. And, also how local stations can be a drawback when it comes to increasing travel time, as well as increasing city budgets for construction of the lines, maintenance, repairs, staffing, and other costs for increased services.
Wrapup
If necessary, have students label their iPads so they will be able to return to them for the next lessons.

Questions
1) Choose the approximate spot for your first local station, and fill in the information below.
   Between: _________________ at ( , ) and _________________ at ( , )

2) Find the slope of the line between the two stations.

3) Now, in the equation y = mx + b, you know x and y (choose the coordinates for one of the stations) and m, slope. Plug those three numbers into the equation and solve for b, the y-intercept.

4) Now you know m and b, what is the equation of the line between the stations?

5) What is the x coordinate of the local station you are creating? x = ______

6) Plug that x value into your equation to find y. y = _______

7) What are the coordinates for your first local station? ( _____, _____ )

8) In the space below, find two more local stations, show the work you do to find the coordinates of the new stations.

9) Why did you choose locations for your 3 new local stations? Did they serve the city in a way that is helpful for traveling passengers?

10) How can local stations help subway passengers?

11) Do local stations have any drawbacks for passengers or any aspects of the subway system?
The map students use for this lesson should look something like this map. Choreo Graph provides the coordinates and line segments representing the subway lines.