emcsquared: Atlanta Bound

Title:	**Grade: 8th Grade**	**BIG Idea:**
Atlanta Bound! ***Based on lesson *Fund Raising* found in NCTM's *Navigating Through Algebra in Grades 6-8***	**Author(s)**: Kelley Taylor Amy Latta-Won Hope Phillips	**Linear Equations**

Prior Knowledge Needed:

Students should be able to ...

- Define a variable, write an equation, solve the equation, and interpret the solution (M7A2a.);
- define independent and dependent variables given a scenario;
- write and solve multi-step equations;

GPS Standards:

M8A4. Students will graph and analyze graphs of linear equations.

a. Interpret slope as a rate of change.
b. Determine the meaning of the slope and y-intercept in a given situation.
c. Graph equations of the form $y = mx + b$.
g. Solve problems involving linear relationships.

M8P1. Students will solve problems (using appropriate technology).

M8P3. Students will communicate mathematically.

M8P4. Students will make connections among mathematical ideas to other disciplines.

M8P5. Students will represent mathematics in multiple ways.

Objectives:

1. Students will interpret the slope of the line in the context of a problem using the appropriate units.
2. Students will interpret the y-intercept of the line in the context of a problem using the appropriate units.
3. Students will develop a linear equation in slope-intercept form to describe a set of data.
4. Students will explore relationships among lines, slopes, and y-intercepts
5. Students will connect linear relationships in real-world contexts.

Materials:

Excel or other spreadsheet application
Worksheets (see *Resources* section)
Computers for students
OR
Capability of teacher to project spreadsheet application for entire class

Task:

The art club at your school is making posters of their original work to sell. They are planning a trip to the High Museum in Atlanta and need money to pay for the bus, driver, and gas. They will sell the posters for $5 each. A local printing company charges a base fee of $280, plus $1.50 per poster for colored ink. How many posters must they sell to make a $500 profit?

Description and Teacher Directions:

This activity requires students to develop a more elaborate table and graph based on information given in the problem. Help students translate among these.

The lesson is designed to use Excel or other spreadsheet application so that students can see a large amount of data quickly. For tutorials on using Excel, search www.youtube.com There are hundreds from which to choose.

A sample of the problem using Excel can be found in the *Resources* section. After completing the task using Excel, students can develop a linear equation in slope-intercept form showing the relationship between the number of posters printed and profit earned.

If computers are not available, the activity may be completed using a graphing calculator or graphing utility found online. Regardless of the technology used, additional materials can be found in the *Resources* section below (i.e. table and questions).

In the *Resources* section, there is an Excel document containing three (Excel) sheets. They are the following:

1. Display for Teacher: This is an answer sheet. In the symbollic representation, the variable "n" has been substituted for "p".
2. Display for Students: This can be shown to the entire class, or students can copy the headings on their own Excel spreadsheets.
3. Template of Equations: Equations for each column have been entered and are ready for teacher/student to "drag down" using the ***fill handle*** (the **darkened** section of the cell in the bottom right-hand corner) to auto-fill each column with answers. NOTE: Begin auto filling the "Number of Posters" column first, and then drag successive columns. Erroneous values will appear if any previous column has not be filled before filling the next column.
4. Scatter Plot: A graph of the number of posters vs. profit.

The worksheets provided in the *Resources* section were created to elicit two kinds of algebraic representations: recursive and explicit rules. The table worksheet corresponds to Sheet 1 in the Excel spreadsheets. In the "A" columns, students should write rules based on the patterns they observe. In the "B" columns, students should develop a rule that works for the printing of any number of posters, or *n* posters. Depending on students' level understanding, the teacher may want to delete the "A" columns from the table.

While some students may quickly develop the rule representing the relationship, others may need a detailed explanation. See below.

- Base cost to begin the project with the printing company: $280
- Explicit rule for cost to print posters: printing costs = $280 + $1.50p, where p is the number of posters.
- While the above rule will yield printing costs, it but does not consider profit.
- Profit is the "selling price" less the "cost to print"
- Explicit rule for "selling price": selling price = $5p, where p is (still) the number of posters
- By uniting both rules, we can symbolically represent "profit" --

profit = selling price - cost to print

P = $5p - ($280 + $1.50p)

Teacher Commentary:

P = $5p - $280 - $1.5p

P = $3.50p - $280

To find the number of posters that must be sold to break even (where sales and cost are equal), substitute "0" for P.

$0 = $3.50p - $280

$280 = $3.50p

80 = p (80 posters must be sold to break even.)

- To find the number of posters that must be sold to attain a profit of $500, substitute $500 for P.

$500 = $3.50p - $280

780 = 3.5p

222.8 = p

Because a fraction of a poster cannot be sold, 223 posters must be sold to make a $500 profit. *Exactly* $500 profit is not achieved. Rather, the profit is $500.50.

To see that this relationship is linear, students should graph the data in Excel using a scatter plot. Select the columns entitled *Number of Posters* and *Profit*. These are the x and y variables, respectively.

Because the data is discrete, a discussion of discrete vs. continuous data would be appropriate. The x-variable represents the number of posters being printed. Since only whole numbers of posters can be printed (no fractional amounts), there will not be a line connecting them. Note that there appears to be a line connecting the data points due to the large number of data points. However, the data are discrete.

Help students explore the meaning of slope as the *real* cost per poster (selling price - cost to print) the and y-intercept as the cost to work with the print shop before even one poster is printed. Look for the break-even point, where cost is equal to profit (80 posters) . Ask students to find the number of posters that would result in a minimum profit (81 posters; $3.50 profit).

Ask students which representation -- tabular or graphical -- they prefer to use to answers questions. Consider that one representation may be more efficient than the other, depending on the question. For example, to find the break-even point, minimum profit point, and the $500 profit point, the table is probably easier to use. To answer general questions, the graph is probably easier because it gives a quick snapshot of the data as a whole.

Student worksheets are provided below in the *Resources* section. Answers are provided, also.

This activity can be completed in pairs or groups to foster mathematical communication, facilitate deep discussion, and discovery.

Resources:

Spreadsheet Examples - 3

Atlanta Bound Worksheets.doc

Atlanta Bound Worksheets [Answers].doc

Assessment Item Answers [Atlanta Bound].doc