# RUN! SpeedLab

An interdisciplinary lab activity using Excel

Mary Bozenmayer
MSET Ramapo
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# Introduction

8th grade Physical Science
Macopin Middle School
On-grade, Special Education, & Honors Students
Class Size Varies, 14-31 students

# Goals and Objectives

- ★ Students will participate in an experiment to answer the question: *"What is the effect of moving different ways on a person's speed?"*
- ★ Students will use data and graphs to determine slope, speed, and then develop a team conclusion regarding their hypothesis.
- ★ Students will build upon skills acquired in math class, reinforcing and making connections between speed, rate, interpreting distance-time graphs and real-life uses of these skills.

**This lesson was developed as part of a Science Department initiative to support the Math Department in Common Core Standards that easily bridge disciplines.**

# NGSS/ Common Core

CCSS.MATH.CONTENT.8.EE.B.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.

MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

# Project Timeline

Two to three 45 minute class periods in total.

- ★ Introduction to Speed at kick-off of unit (includes the “hook”) over one class period
- ★ About a week later, after further instruction; class discussion; whole-group, small-group and independent practice; students will conduct the RUN! SpeedLab over 1-2 class periods.

Using Twitter to increase student excitement!

# Activities

**1st 45 minute period:** Introduction to speed and speed calculations with a few volunteers executing time trials in the hallway (the hook)

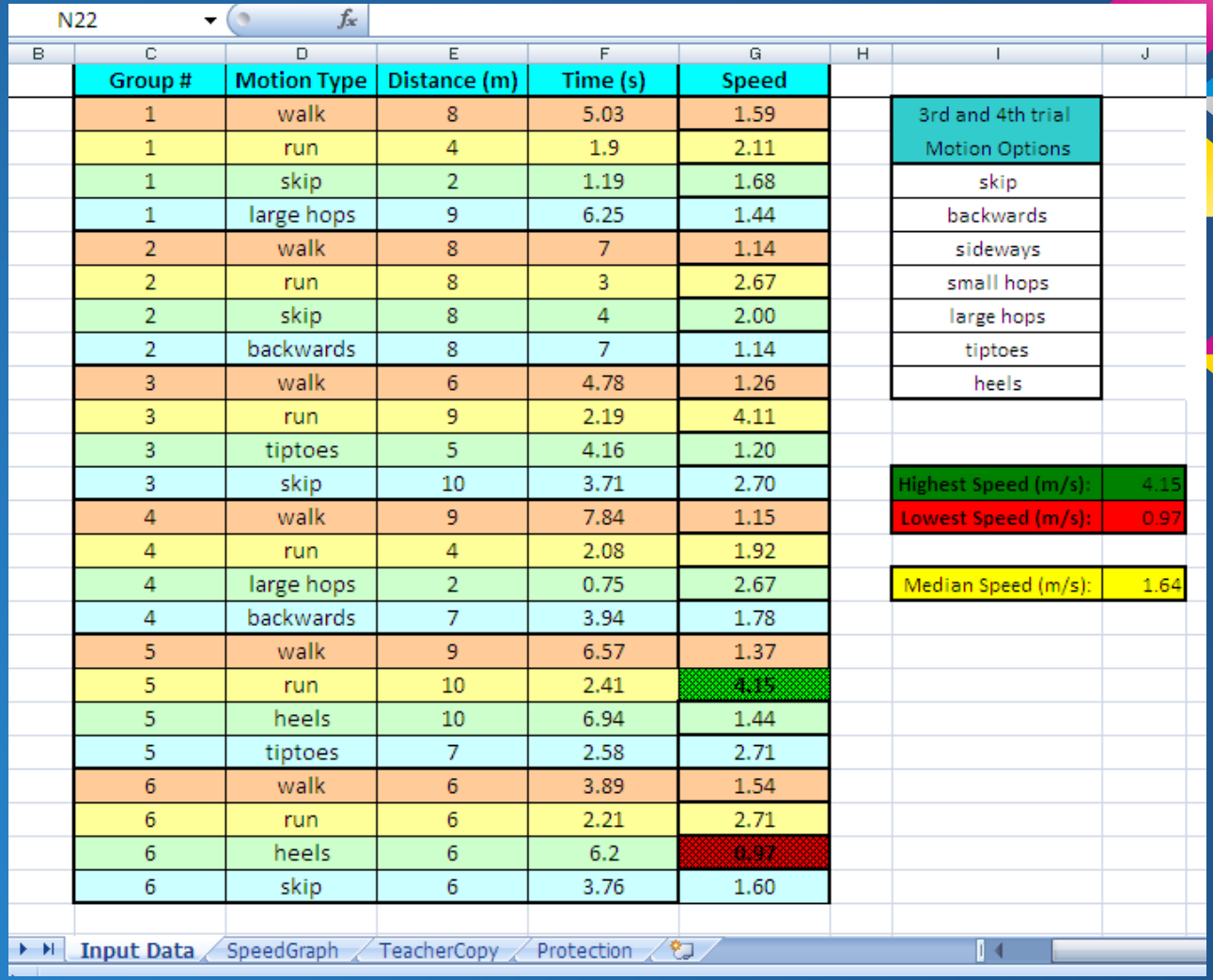
**2nd 45 minute period:** Students work on Pre-Lab (using a graph to find rate), Students generate hypothesis and complete 4 trials with various modes of movement, input data in class Excel sheet.

**3rd 45 minute period (partial):** Students continue/complete analysis of class graph and form a conclusion.

# Spreadsheets

- Students will input their data into a class spreadsheet, projected at the front of the room.
- Spreadsheet uses drop-down menus, pre-set formulas to determine speed (Using the d=rt formula), as well as maximum speed, minimum speed, and median speed for each class.
- Print set-up enables a hard copy of the data given to each group for student notes, but does not include max/min/median so students are encouraged to determine those from the class graph.

# Spreadsheet



N22

| Group # | Motion Type | Distance (m) | Time (s) | Speed |
|---|---|---|---|---|
| 1 | walk | 8 | 5.03 | 1.59 |
| 1 | run | 4 | 1.9 | 2.11 |
| 1 | skip | 2 | 1.19 | 1.68 |
| 1 | large hops | 9 | 6.25 | 1.44 |
| 2 | walk | 8 | 7 | 1.14 |
| 2 | run | 8 | 3 | 2.67 |
| 2 | skip | 8 | 4 | 2.00 |
| 2 | backwards | 8 | 7 | 1.14 |
| 3 | walk | 6 | 4.78 | 1.26 |
| 3 | run | 9 | 2.19 | 4.11 |
| 3 | tiptoes | 5 | 4.16 | 1.20 |
| 3 | skip | 10 | 3.71 | 2.70 |
| 4 | walk | 9 | 7.84 | 1.15 |
| 4 | run | 4 | 2.08 | 1.92 |
| 4 | large hops | 2 | 0.75 | 2.67 |
| 4 | backwards | 7 | 3.94 | 1.78 |
| 5 | walk | 9 | 6.57 | 1.37 |
| 5 | run | 10 | 2.41 | 4.15 |
| 5 | heels | 10 | 6.94 | 1.44 |
| 5 | tiptoes | 7 | 2.58 | 2.71 |
| 6 | walk | 6 | 3.89 | 1.54 |
| 6 | run | 6 | 2.21 | 2.71 |
| 6 | heels | 6 | 6.2 | 0.97 |
| 6 | skip | 6 | 3.76 | 1.60 |

| 3rd and 4th trial Motion Options |
|---|
| skip |
| backwards |
| sideways |
| small hops |
| large hops |
| tiptoes |
| heels |

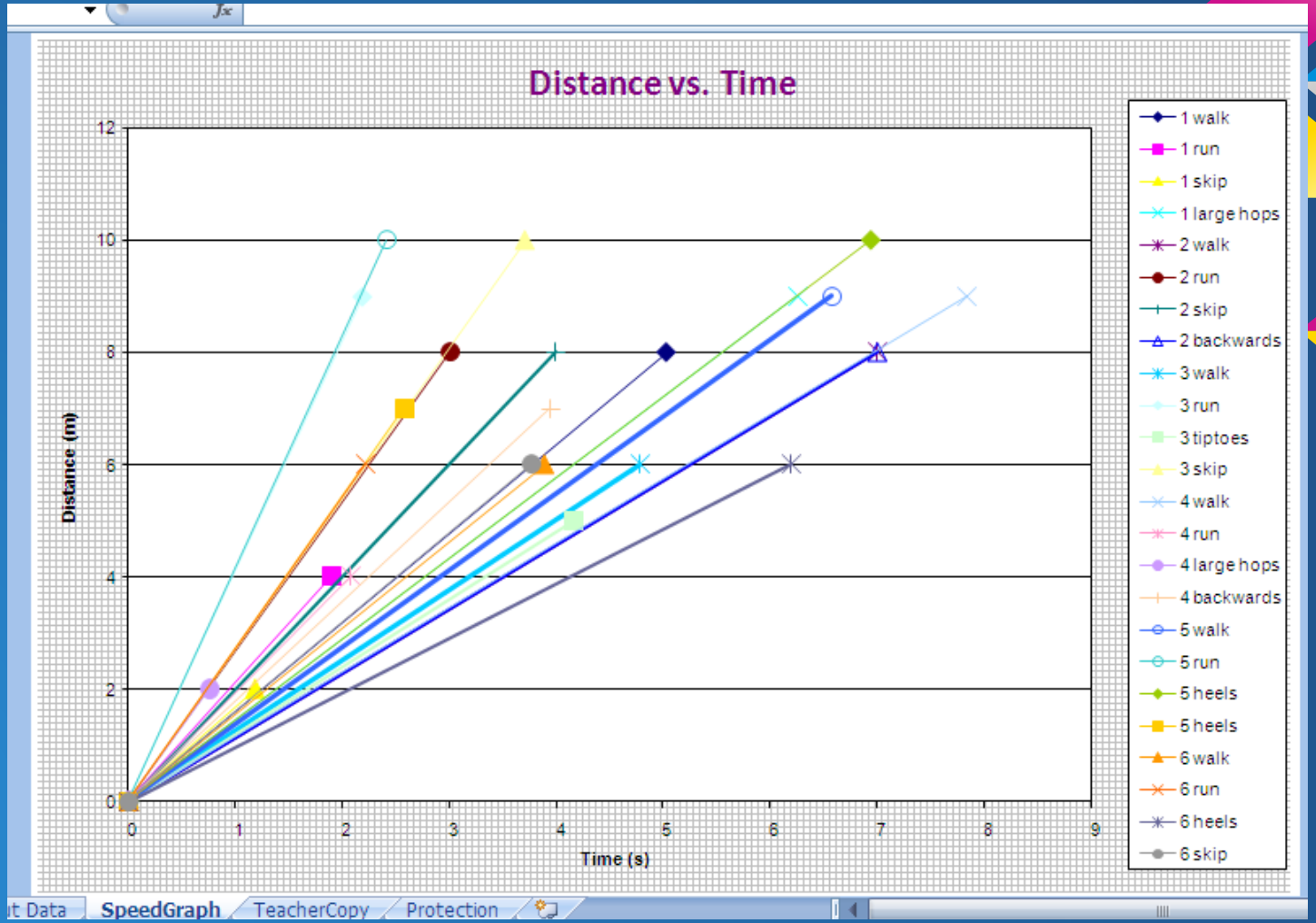
| | |
|---|---|
| Highest Speed (m/s): | 4.15 |
| Lowest Speed (m/s): | 0.97 |
| Median Speed (m/s): | 1.64 |

Input Data | SpeedGraph | TeacherCopy | Protection

# Graphs

- Class graph is pre-set to generate a line for each time trial.
- Each line is color-coded and graph includes a key that displays the team # and mode of movement.
- Students are encouraged to determine a QUALITATIVE way of determining the fastest method of movement, as well as the slowest and the median in discussion with their group as they view the graph.

# Graph


Distance vs. Time
Distance (m)
Time (s)
0
2
4
6
8
10
12
0
1
2
3
4
5
6
7
8
9
1 walk
1 run
1 skip
1 large hops
2 walk
2 run
2 skip
2 backwards
3 walk
3 run
3 tiptoes
3 skip
4 walk
4 run
4 large hops
4 backwards
5 walk
5 run
5 heels
5 heels
6 walk
6 run
6 heels
6 skip
t Data
SpeedGraph
TeacherCopy
Protection

# Application

After conducting their time trials, students will be given a hard copy of the class data and Excel-generated graph.

The class data and graph will also be projected at the front of the room, live-updating as each group adds their data.

## Application

Students will interpret the larger class set of data to answer the following questions and then reflect on their hypothesis to form a conclusion:

- What does the **slope** of each line represent in this activity? *(Think of the variables in the d=rt formula.)*
- When you observe the class distance-time graph, which includes the data from all your classmates' trials, explain what **quality of the line** you look for to find…..
  - ❖ What is special about the line that shows the **highest** speed? (Also, **lowest**, **median**)
    - ➢ Which group had the highest speed?
    - ➢ What type of motion did they use?

# RUN! SpeedLab

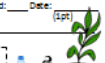
## Pre-Lab

My Name: _____ Period: ___ Date: (1pt)

My partner (s): _____

**RUN! Pre-Lab Warm-Up:** [Pre-Lab Total Points: 12]

**Using a graph to find RATE**



Several students in Mr. Hall's class collected the following data representing the height of two growing seedlings over several days. Plot the data on a coordinate plane and find the line of best fit to create a distance-time graph.

| Day # | Watered Plant Height (cm) | "Coffeed" Plant Height (cm) |
|---|---|---|
| 1 | 2 | 2 |
| 2 | 4 | 3 |
| 3 | 6 | 4 |
| 4 | 8 | 5 |
| 5 | 10 | 6 |

Be sure to spread out your data to make a graph that shows differences easily!

Title: _____

y: _____ measured in _____

X: Time measured in _____

1. What is the formula to find the slope of a line?

2. How can you use this graph to find the average growth rate of the seedlings?

3. Which plant is growing faster?

4. How can you tell by just looking at the graph?

5. How much faster? *(be sure to include units!!)* (2)

**Key:** *(what symbol/color/line type is what)*



**RUN! SpeedLab** [Lab Total Points: 28]

**Problem/Question:** What is the effect of moving different ways on a person's speed?

**Hypothesis:** if _____,

then _____. [2pts]

**Materials:** stopwatch measuring tape computer & Excel file *RUNspeedlab.xls*

Deck of playing cards at least two teammates (will vary in larger classes)

**Procedure:**

1. **Prepare.** Clear a 10 meter "runway", free of any obstructions. Attach the measuring tape securely to the floor.
2. **Choose roles.** For each trial, one team member will track distance traveled, one team member will measure time with the stopwatch, one team member will record data and one team member will walk, run, etc.
3. Pick a card from the pile on the front counter. Your first trial will cover the # of meters on the card.
4. **Conduct** the first trial while walking, the second running, and for the third and forth trials you may choose from the following motions: **skip, backwards, sideways, small hops, large hops, tiptoes, heels.**
5. **Calculate** your speed for each trial using the speed formula. r= d/t, rate equals distance divided by time
6. **Report** your data by entering it into the class Excel file on the main computer. Use this to check your speed calculations!
7. **Observe** the class Distance vs. Time graph (on the second tab in the Excel sheet.) You may need to wait for your classmates to complete their trials. Your teacher will print your group's data table and graph.
8. **Think, Discuss, Complete** the analysis questions with your team. (4pts)

| Motion Type | Group Member Name | Distance (m) | Time (s) | Speed (m/s) |
|---|---|---|---|---|
| Walk | | | | |
| Run | | | | |
| Other: | | | | |
| Other: | | | | |

STAPLE YOUR PRINTED COPY OF CLASS DATA AND GRAPH [2pts]



## Analysis

Be sure to STAPLE YOUR PRINTED COPY OF CLASS DATA AND GRAPH to this lab.

**Summarize Your Findings** [12 pts + BONUS]

1. What does the slope of each line represent in this activity? *(Think of the variables in the d=rt formula.)*

_____

_____

2. When you observe the class distance-time graph, which includes the data from all your classmates' trials, explain what **quality of the line** you look for to find.....

- What is special about the line that shows the **highest** speed?
  - Which group had the highest speed? _____
  - What type of motion did they use? _____
- What is special about the line that shows the **lowest** speed?
  - Which group had the lowest speed? _____
  - What type of motion did they use? _____
- What is special about the line that shows the **closest to median** speed for the class? *(BONUS! +1pt)*
  - Which group had the closest to median speed? (estimate) _____
  - What type of motion did they use? _____

3. Ok, it is time to prepare your conclusion. First, let's collect all the important aspects of a good conclusion:

A. What was your hypothesis?

_____

_____

B. Was your hypothesis correct? YES *or* NO *or* KINDA

C. Discuss your results. What is some data from the experiment that helps support your decision that your hypothesis was correct or incorrect? Include at least two numbers or calculations below: *(2pts.)*

D. If you conducted this experiment again, what would you fix/ what new thing would you like to try?

_____

_____

Ok, now **AS A TEAM**, you will write your conclusion. Each team member should write **at least one sentence**. ↓

# Evaluation

Students will be evaluated on their responses on the pre-lab, analysis questions, and final conclusion statements. Total Lab point value: 40

The conclusion rubric is shown below:

| **Criteria** | Team Conclusion Grade (**8 points** total) | | | |
|---|---|---|---|---|
| Restate hypothesis | | | Included | Not Included |
| Was hypothesis correct | | | Included | Not Included |
| Cite at least two pieces of data to back up evaluation of hypothesis | 2 pieces of data used and connection explained | Less than required pieces of data used OR data not thoroughly unexplained | Data not explained | Data not included |
| What would you do differently next time? | | | Included | Not Included |
| Each team member writes at least one sentence of **conclusion** | | Evidence of <u>all</u> team members' contribution | More than one but not all team members' contributions evident | Only one team member completed the conclusion |

# Brainy Bits

**Some of Gardner's Intelligences:**

*Kinesthetic Learners* will be thoroughly engaged in this lesson that encourages them to move freely, in a way that is unexpected in the classroom.

*Visual Learners* will be engaged through the use of the projector, color coding in the Excel-generated class speed graph, and the need to interpret relationships between visual slopes of lines.

*Logical/Mathematical and Visual/Spatial Learners* will easily grasp the connection between the slope of a distance-time graph and the speed of a person's movement, as well as the physical distance travelled in the classroom in an amount of time.

# Brainy Bits (continued)

## Activating Lobes of the Brain

- **Frontal Lobes**
  Higher order thinking skills, connecting visual graphs to real-life motions, focus
- **Motor Cortex**
  Movement during lab activities (Run, walk, skip, hop, etc)
- **Occipital Lobes**
  Visualizing data in the spreadsheet.
  Interpreting the slopes of the data on the class graph.
- **Parietal Lobes**
  Calculating the differences in rate and speed in both the pre-lab and lab activities.
  Spatial orientation when engaging in different movements and navigating classroom of 30 students all running/skipping/etc in a small space.

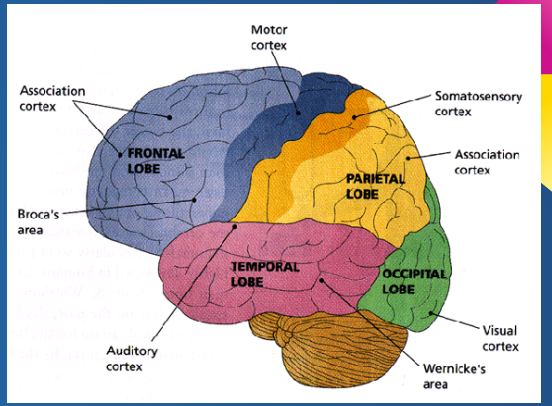



Image Source: https://lingtechguistics.files.wordpress.com/2008/08/lobes2.gif

# Citations/Resources

Gardner, Howard. Intelligence Reframed: Multiple Intelligences for the 21st Century. New York: Basic Books, 1999.

Sousa, David A. How the Brain Learns. Thousand Oaks, CA: Corwin, 2006. Print.