**Subject area/course**: Mathematics

**Grade level/band**: 9

**Task source**: Summit Public Schools

**Graphing Stories**

**TEACHER'S GUIDE**

1. **Task overview**:

Students will create an accurate graph of a real life scenario, as well as a model for how the graph will change as a real life variable is increased or decreased. The final product will include the 15-second video, the graph, and a detailed explanation of that graph.

1. **Aligned standards:**
2. **Primary Common Core State Standards**

**[HS F.IF.B.4](http://www.corestandards.org/Math/Content/HSF/IF/B/4/)**- For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.

**HS F.IF.B.5** - Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*\*

**HS F.IF.C.7** - Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.\*.

1. **Secondary Common Core State Standards (optional)**

**[CCSS.MATH.CONTENT.HSF.IF.C.8](http://www.corestandards.org/Math/Content/HSF/IF/C/8/)** - Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

1. **Critical abilities**

*Experimentation/Evaluation*: Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. Evaluate hypotheses, data, analysis, and conclusions, verifying the data when possible and corroborating or challenging conclusions with other sources of information (in speedwalker task and video creation).

*Communication in Many Forms*: Use oral and written communication skills to learn, evaluate, and express ideas for a range of tasks, purposes, and audiences. Develop and strengthen writing as needed by planning, revising, editing, and rewriting while considering the audience (graph explanation, video, group activities, oral communication).

*Use of Technology*: Present information, findings, and supporting evidence, making strategic use of digital media and visual displays to enhance understanding. Use technology, including the Internet, to research, produce, publish, and update individual or shared products in response to ongoing feedback, including new arguments or information (desmos, video, PowerPoint).

*Interpersonal Interaction and Collaboration*: Develop a range of interpersonal skills, including the ability to work with others, to participate effectively in a range of conversations and collaborations.

*Modeling, Design and Problem Solving*: Use quantitative reasoning to solve problems arising in everyday life, society, and the workplace, e.g., to plan a school event or analyze a problem in the community, to solve a design problem or to examine relationships among quantities of interest. Plan solution pathways, monitoring and evaluating progress and changing course if necessary, and find relevant external resources, such as experimental and modeling tools, to solve problems. Interpret and evaluate results in the context of the situation and improve the model or design as needed.

1. **Time/schedule requirements:**

This task will take approximately 2-3 weeks to complete, depending on your school schedule and other activities.

1. **Materials/resources:**
* Item A. Movie Intro and Pictionary PPT
* Item B. Graphing Stories Day 2 PPT
* Item C. Graphing Stories Day 3 PPT
* Item D. Relay Races and Acting PPT
* Item E. Math Race Task Sheets PDF
* Item F. Math Race Graph Sheet PDF
* Item G. Acting Out the Graphs PDF
* Item H. Intro to the Final Product & Video Editing PPT
* Item I. Intro to the Final Product and Video Editing
* Item J. Copy of Tech Set Up Slides
* Round the Bases.mov
* Clear water jug/vase (different shapes/sizes)
* Water and small cup/bucket to fill jug/vase
* Graphing Stories Rubric
* Desmos (teacher account)
* Chromebooks/Computer Lab for desmos student activities
* Stop watches/timer for races
1. **Prior knowledge:**

Know the structure of the coordinate plane and how a graph is organized

General understanding of linear, exponential, trig, quadratic functions

1. **Connection to curriculum:**
2. **Teacher instructions:**

Step 1 (Item A. Movie Intro and Pictionary Powerpoint File)

* Review the objectives for the day (on Powerpoint)
* Play the 15 second Rounding the Bases video 3 times.
	+ 1st Play: Have students watch the video <http://tinyurl.com/j7cg53d>
	+ 2nd Play: Have students look for quantities to measure. Make a list on the board of quantities we could measure. Possible questions to pose: Which quantities change over time? Which do not? Of those that change, which change smoothly?
	+ 3rd Play: Tell students to look for the distance from the pitcher’s mound. Possible questions to pose: How is it changing? What is the starting distance? What’s the ending distance?
* Have students choose a quantity to measure from the Round the Bases video to construct a sketch. Possible quantities include (aside from pitcher’s mound distance), baseball’s distance from home plate, player’s distance from home plate, choosing another base as a reference point, or distance traveled over time. Possible outline of sketch requirements is available on Powerpoint.
* After students have constructed a sketch, select a few examples (teacher discretion here) to discuss/share as a class. Highlight positive features of graphs and/or save a list of the features on a poster for later use.
* Discuss the meaning of mathematical models with students. Give an overview of the 15-second video project and cognitive skills required.
* Play Level 1: Graphing Pictionary. Have a set of different functions printed or on cards. One person in the team (the “describer”) will orally describe the graph and the other one or two group members (the “graphers”)must draw it on their cards.
	+ Process the game/teamwork with the class. Possible questions are on Powerpoint (What strategies worked well for your group?, What strategies did you try that didn’t work well? How did you communicate as a group to change them?
* Lesson closure/reflection

 Step 2 (Item B. Graphing Stories Day 2 Powerpoint File)

* Review the objectives of the day, key terms and practice identifying independent and dependent variables (on Powerpoint)
* Have students spend some time using websites for practice <http://tinyurl.com/92variables> and <http://tinyurl.com/92axes>
* Bring the class together and demo the Function Carnival activity. Have students watch the cannonball man and demonstrate how to sketch the graph. Show students that we can pause and put points at given places to get a more accurate graph.
* Have students play the Function Carnival (group activity) on Desmos. You will have to create a teacher account and setup function carnival at <http://teacher.desmos.com>. Students will experience the Function Carnival (test student demo by going to [student.desmos.com](http://student.desmos.com) and entering class code vypd
* Review the reflection questions at the end of the powerpoint.

 Step 3 (Item C. Graphing Stories Day 3 Powerpoint File)

* Start by having students discuss/identify the possible independent and dependent variables from this video: http://tinyurl.com/omkm7du or <https://www.youtube.com/watch?v=Wmpz41sqV5I>
* Pour water into a glass (if materials are available, if not use the video) and talk about it. How does the height of the water change over time? What happens if I pour more slowly or faster? Let’s try to sketch a graph of each demo (?)
	+ display a timer as teacher pours
	+ round of pouring at different rates into same container
	+ round of pouring at same rate into different containers
* Ask students to sketch a possible graph for the water pouring video. Keep in mind the shape/volume of the jar/jug and how it (the height) changes over time if the pour is happening at a constant rate. This is a demo for the waterline activity in desmos. (To preview the desmos task o to student.desmos.com and enter code rywz)
* Start with the “Waterline walkthrough”

<https://teacher.desmos.com/waterline>

* Discuss the Infographic project with a focus on data collection, etc. And have students brainstorm their context for the final video
	+ What does it mean to collect data / what levels of precision are needed
	+ Google form (or email) with their idea - “Sign up” for their infographic
	+ Teacher will email with confirmation or suggestion to change
	+ Here, it will be really important to frame this as a SHIFT from Graphing Stories, and help kids understand why we’re asking them to sign up now.

Step 4 Item D. Graphing Stories Day 4 Relay Races and Acting Powerpoint File

* Start by having students describe the "story" for the graph on the warm up powerpoint slide
* Review the goals for the day and the "Math Race" (outside of the classroom) instructions
	+ Students will get into groups of 4-6 and have 3 different task cards (Item E Math Race Task cards.pdf)
	+ Group roles include 1-3 runners, 1 timer, 1 facilitator
	+ Tell students they will be graphing the distance of the runner/walker over time. Students can use the task cards document to collect data or collect any/all data possible without prompts.
	+ Students should come back and sketch their graphs with key features on Item F Math Race Graph Sheet.pdf
* Process the Math Race activity
	+ Possible questions include Which graph was easiest to make? Which graph was hardest? Why? Why is it important to have the correct times recorded? How did your group do at this?
* Introduce the "Acting Out the Graphs" activity
	+ Model the task by using the step function on the powerpoint slide
	+ Use the Item G. Acting Out the Graphs.pdf graphs
	+ Students should choose one of the graphs in their group (or in pairs), come up with a <1 minute skit to represent their situation to present to the class. Be sure all students in the group have a role.This will take time to prep. It may be useful to come up with a list of requirements of key features to "skit" as a class.
* Process the activity
* Lesson Closure/reflection

Step 5 Item H. Intro to the Final Project & Video Editing Powerpoint File

* Review the requirements and rubric for the final project
* Have students examine the sample project Item I. Example Graph Story Final (or tinyurl.com/GSexample) and use the rubric to score the task
* Do the "Yes and..." activity where students (in small groups) take turns describing the requirements for the final product.
* Students should now work on their final product
	+ Optional: Show tutorial on how to upload videos to google drive tinyurl.com/GStechnology or Item J. Copy of Tech Setup Slides
	+ Optional: Modeling the graph making process on desmos
		- Make 2-3 graphs (Linear, Parabolic, Step...)
		- Show how to label each axis (wrench/settings)
	+ Optional: Show kids how to use the snipping tool (or chromebook equivalent) to take images of their desmos graph
		- How to upload snipped image into their document
* Give kids time to work on their graphs. Remind them that they may want to take screen shots during the process to include in their final product
* What needs to be in your Graph Explanation?
	+ Connect key graph features to the events in the video
	+ Use specific x and y values referenced to describe parts of the graph and video? (e.g. from 2-5 seconds the man fell from a height of 10 ft to a height of 5 ft)
	+ Use specific and proper graph vocabulary in all references? (e.g. slope, y-intercept, x-intercept, dependent variable, independent variable, etc.)
	+ Use specific mathematical vocabulary used throughout explanations? (e.g. positive, negative, increasing, decreasing, constant)
	+ Logical and well organized
	+ Numerical values all include proper units?
	+ Discuss sources of error in your project. Were steps taken to minimize error? Why or why not?
* Lesson Closure / Reflection / Peer Review
1. **Student support:**

Possible accommodations should include guided notes, checklist for students who need to keep track of requirements, preferential group/seating, frequent check-in, additional teacher feedback, extended time, read alouds, guides on different functions (linear, quadratic, exponential), tutorials on using the technology (chromebooks, desmos).

1. **Extensions or variations:**

Ask student to write functions (equations) that describe their graphs/video.

1. **Scoring:**

Student work can be scored using the Graphing Stories Rubric.