Poster Problems

On the Download

Seventh Grade Poster Problem
Expressions and Equations

When you download movies, games, or other items with a large amount of data to your phone, the download process may take a long time to finish. But how long, exactly? This problem uses cell phone download speeds as a context for setting up and solving linear equations. The mathematical goals are to solve equations for a specific value and to represent a delayed start time meaningfully.

Learning Objectives:

- Represent proportional relationships in equations and identify/compare constants of proportionality.
- Consider the effect of a delayed start time and represent in meaningfully in tables and graphs.

Connect the language of a word problem or situation to an equation in the form of $px + q = r$ and $p(x + q) = r$.

- Explore a situation that relates to a system of equations.

Common Core State Standards for Mathematics:

7.EE.B.4a

Teacher Tune Up:

- Problems with Different Speeds and Start Times
- How do you write an equation from a situation, story or pattern?
- Variable, Parameter, Unknown: What's the Diff??

The way this works: one lesson in six phases

LAUNCH

Teachers set the stage by leading an introductory discussion that orients students to the context of the problem.

POSE A PROBLEM

Teachers introduce a mathematical way of thinking about the context and engage students in a preliminary approach that opens the door to the workshop phase.

WORKSHOP

The workshop starts with a more challenging and more open-ended extension of the problem. In teams, students plan and produce mathematical posters to communicate their work.

POST, SHARE, COMMENT

Teams display their posters in the classroom, get to know other teams' posters, and attach questions/comments by way of small adhesive notes (or similar).

STRATEGIC TEACHER-LED DISCUSSION

Teachers then compare, contrast and connect several posters. In the process they highlight a progression from a more basic approach to a more generalizable one. By doing this, teachers emphasize standards-aligned mathematics using student-generated examples.

FOCUS PROBLEM: SAME CONCEPT IN A NEW CONTEXT

Serving as a check for understanding, this more focused problem gives teachers evidence of student understanding.

Day 1

FLEXIBLE

Day 2

1. Launch

Directions for teacher:

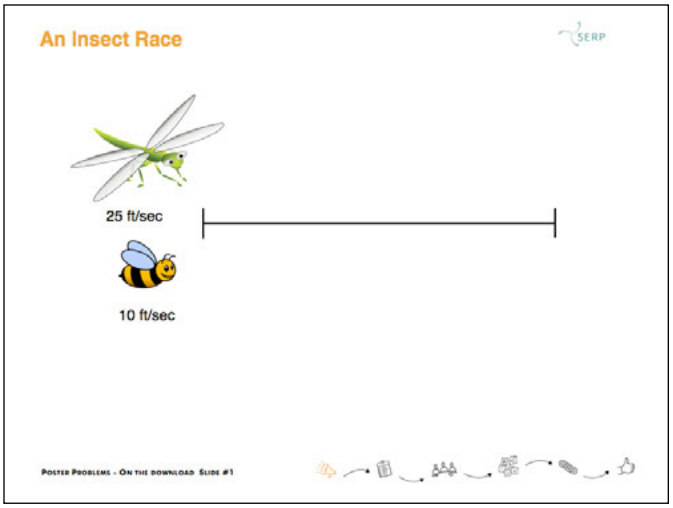
Say to students, "You might remember a different problem about a dragonfly. In that problem we figured out the dragonfly could fly at 25 feet per second. Since we know the dragonfly covers 25 feet per second, the distance it flies can be described with the following equation:

distance = rate × time

"Suppose the dragonfly raced a bumble bee who could fly 10 feet per second. Which insect would win?"

Show **Slide #1.**

Elicit from students that the dragonfly would always win since the dragonfly is faster.

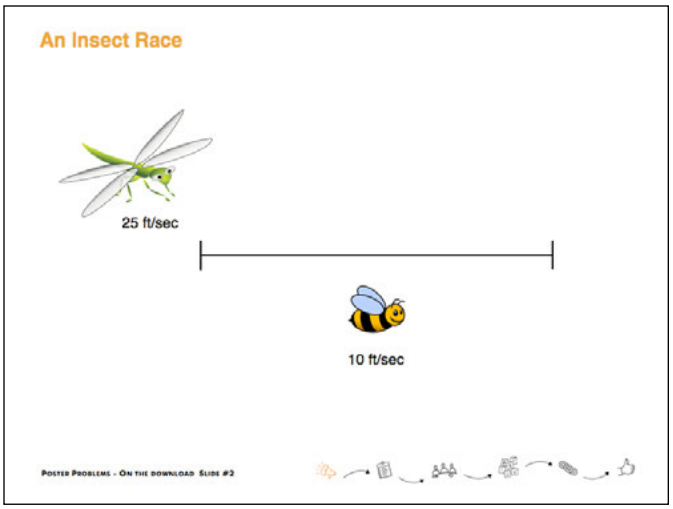


Slide #1 (video)

"How could we make this insect race more interesting? Perhaps we could give the bumble bee a head start? Would the bumble bee win if he had a head start?"

Show **Slide #2.**

Take different answers from students. You should steer the conversation to the fact that we don't have enough information to answer this question. Key things we would need to know include the distance of the head start, and the distance of the race.



Slide #2 (video)

2. Pose a Problem

Directions for teacher:

Say to students, “Today we are going to explore a similar rate problem in a different context. We are going to explore a problem about how long it takes to download a file on a smartphone. Have you ever downloaded a big file on a phone? What did you see? How long did it take? ... Let’s watch this video of two smartphones downloading a file.”

Show **Slide #3.**

> Note: Key variables that determine how long it takes are the rate that the phone can download data, and the total size of the file.

Show **Slide #4.**

Say to students, “The popular "mePhone" was the best smart phone ever when it came out. With the mePhone, you could send emails and text messages, browse the web, watch videos, listen to music, download your homework from the cloud, update your status online... oh, and you could even make phone calls!”

“The mePhone is pretty fast. But the new and improved mePhone2 can download data even faster than the original mePhone. “

“The mePhone can download 2 megabytes of data per second. The mePhone2 can download 3.5 megabytes per second.”

Distribute **Handout #1.**

This handout is a model of a situation: You begin downloading a large file on your mePhone. It is taking a long time. 30 seconds after you start downloading, your brother starts to download the same file on his mePhone2.

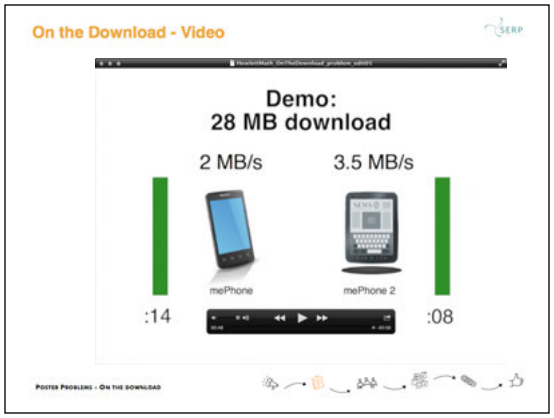
Ask, “Does everybody understand this situation?” Take questions and review the key information as needed.

After students have completed the handout, ask, “What do you notice about the data column for the mePhone2?”

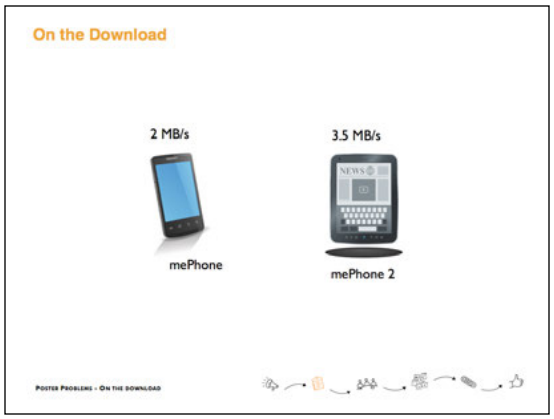
Elicit that the rows show zero data for the mePhone2 for times from 0 to 30. Also, the table does not show the mePhone2 surpassing the mePhone, but students may offer that it is a possibility.

Elapsed Time (seconds)	mePhone data downloaded (MB)	mePhone2 data downloaded (MB)
0	0	0
5	10	0
10	20	0
15	30	0
20	40	0
25	50	0
30	60	0
35	70	17.5
40	80	35
45	90	52.5
50	100	70

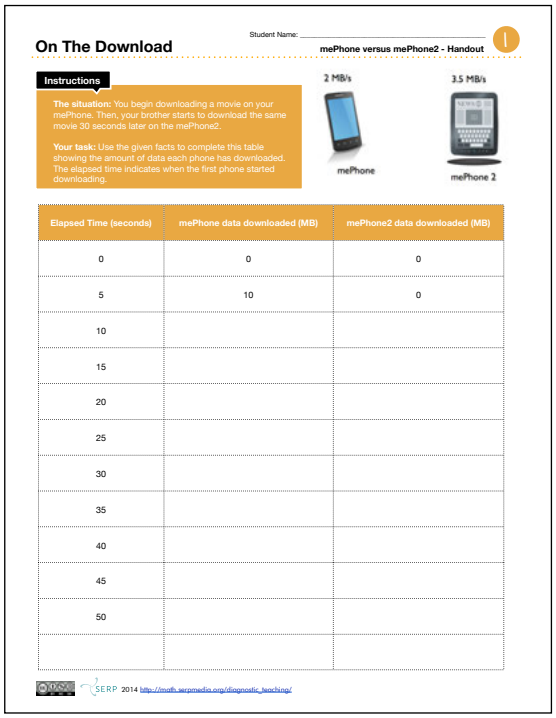
Handout #1 Answers



Slide #3 (video)



Slide #4



Handout #1

3. Workshop

Directions for teacher:

Show **Slide #5**.

Say to students: “Create a poster comparing how the data was downloaded by each phone in **Handout #1**, but consider that the file they were downloading was a 210 MB video.”

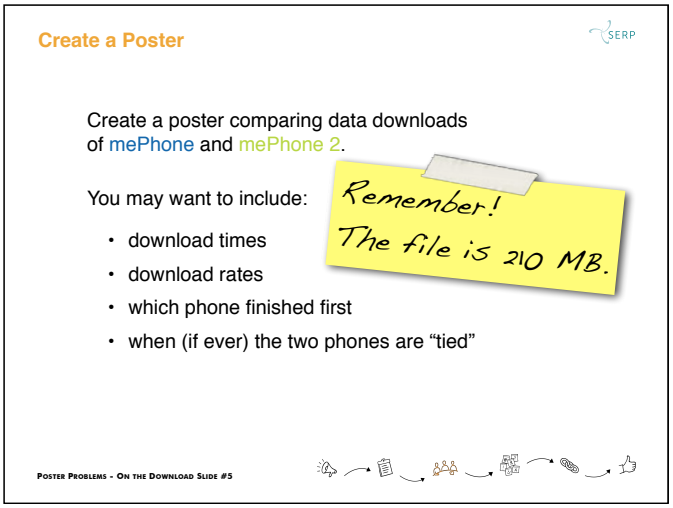
“Use t to represent time in seconds and d to represent downloaded data. You may create an explanation that uses words, a table, an equation, a graph... Or some combination of these representations! Be sure your poster answers the following questions:”

- How long did the phone take to download the file?
- Which phone would finish first?
- Where do we see the rate of each phone’s download?
- When (if ever) were the two phones “tied”? How do you know?

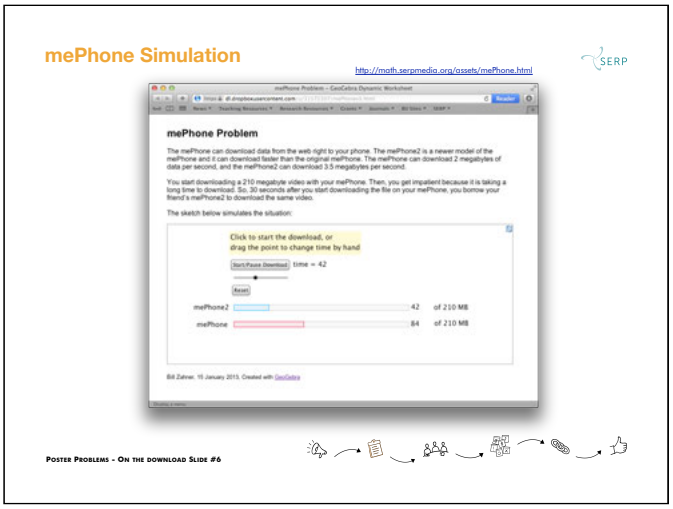
Finally, If your students are stuck, they can explore this problem situation further by experimenting with a dynamic simulation of the mePhone problem. The simulation lets students watch progress bars for each phone gradually move across the screen. Students can start and stop the time with the button, or they can move the time in increments of 0.1 seconds using the slider.

Slide #6:

http://math.serpmedia.org/assets/mePhone.html



Slide #5



Slide #6

4. Post, Share, Comment

Directions for teacher:

Have students post their posters around the classroom.

Encourage students to travel around to view the posters created by other groups. Students should be encouraged to write questions for other groups by attaching a small adhesive notes.

During this time, teachers should be reviewing all the posters and considering which to highlight in Phase 5.

Sample Posters:

Poster A This poster answers the main question, but does not include key details about how the students arrived at this solution. Teacher should ask for more elaboration on how the students computed each total time. [It is likely the students divided the total data by the rate.] Two additional questions that are not answered here are, "Which phone finished first?

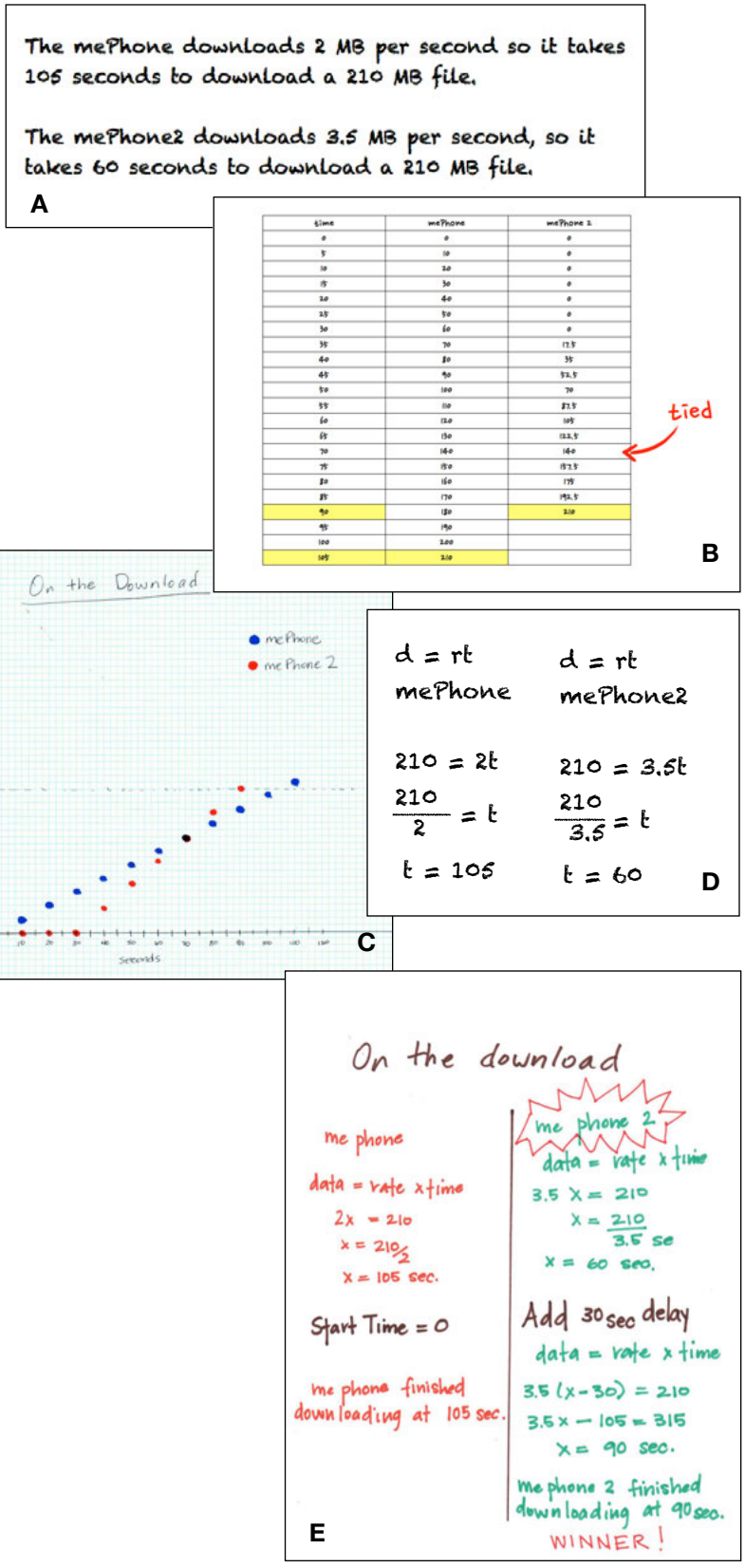
When were the two phones tied?"

Poster B shows an extension of the table from the workshop problem. These students completed the table up to 120 seconds. The chart includes final download times for both phones. A common error to watch out for is putting 17.5 on the line for 30 seconds for the mePhone2.

Poster C shows the work of a group that plotted points to describe the data downloads of both phones. Discussion of this poster might highlight the delay shown by the red points on the x-axis between 0 and 30 seconds, the fact that the mePhone2 finished first, and the fact that we can identify when they were tied [70 seconds] based on this graph.

Poster D These two equations show how long each phone took to download the data. They use a version of the famous d = rt. What is missing, however, is a summary of how the head start that the mePhone had would affect the outcome of the "race." While the solutions to these equations are correct, the question is not really answered. This shows a partial understanding of using an equation.

Poster E shows two equations expressing how long each phone took to download the data. The students use a version of the famous d = rt. The second equation for the mePhone2 shows the thirty second delay with the term (x-30). This student also included a written explanation of what the equations mean.



5. Strategic Teacher-Led Discussion

Directions for teacher:

Your next step is to facilitate a discussion of the probable answers. Select a sequence of posters to use as examples during this discussion to help all students see a variety of good thinking.

There are several effective approaches. The ideal is that students be fluent with each, and can connect them. That will be your goal in engineering the discussion. The "levels" below address the approaches separately: tables, graphs, and equations—but encourage groups that use more than one of these and coordinate them.

Table Levels

T0: No table of values.

T1: Tables that are correct but do not account for the 30-second delay or help find the "tie" point.

T2: Single table accounts for the 30-second delay.

Graph Levels

G0: No graph.

G1: Graph does not account for the delay.

G2: Graph accounts for the delay. It shows points (as from a table) and lets you correctly find answer to the questions about who won or when they tied.

G3: Graph shows lines, and shows (on the graph or though equations attached to the graph) that the slopes are the two data rates. May deal with the time before 30 seconds.

Equation Levels

E0: No equations

E1: Equations based on $d = rt$, with no accounting for the delay. Note that students can still account for the delay "after the fact," i.e., getting an answer of 60 for the mePhone2 and adding 30 seconds.

E2: Two equations; the mePhone 2 version accounts for the delay ($d = 3.5(t - 30)$). Group plugs in 210 MB and solves to find the two times.

E3: Like E2 but includes solving for the "tied" time (70s, 140MB) by setting the two equal to each other and solving.

Questions to ask across presentations

- Where is the data rate (2 or 3.5 MB per second) in your display?
- How can you tell when they're tied? [See the intersection on the graph; solve $2t = 3.5(t - 30)$.]
- What happens to the mePhone 2 before 30 seconds? How do you show that in your display?
- What are the advantages of using an equation? A graph? A table?
- Suppose the mePhone 3 has a data rate of 7.5 MB per second. Which technique would make it easiest to solve a new problem with the mePhone 3? [The equations: you only have to swap out one number.]

6. Focus Problem: Same Concept in a New Context

Directions for teacher:

Distribute **Handout #2.**

The Focus Problem Challenges students to extend the rate equations to include reasoning about the cell phone plan required to use the phones.

Answers to **Handout #2:**

1. Which plan is better? Well, it depends on how much you use your phone to make calls. Use a table graph, and/or equation explain which plan is better for each person:

   a. Talkative Ted who talks for **520 minutes** or more each month. **(Answer: Pay as you go)**

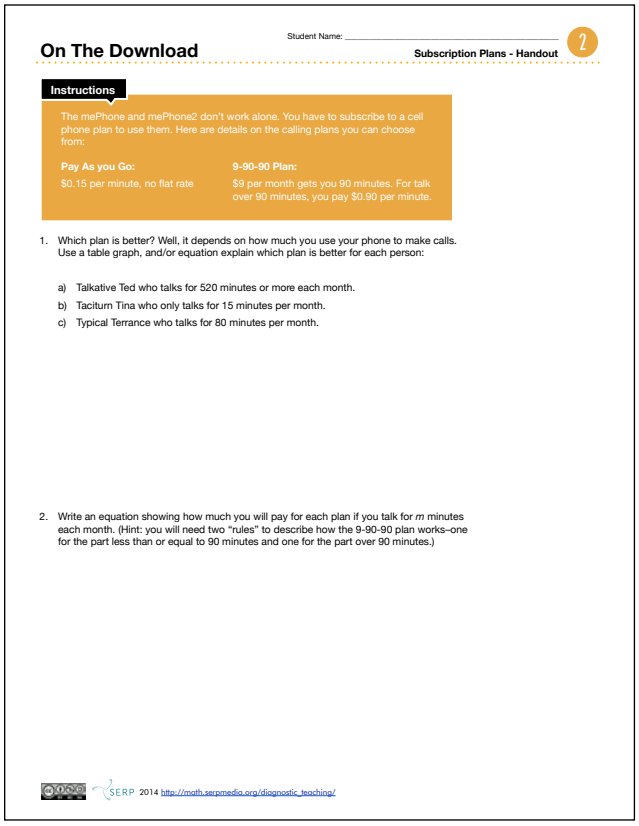
   b. Taciturn Tina who only talks for **15 minutes** per month. **(Answer: Pay as you go)**

   c. Typical Terrance who talks for **80 minutes** per month. **(Answer: 9-90-90)**

2. Write an equation showing how much you will pay for each plan if you talk for *m* minutes each month. (Hint: you will need two "rules" to describe how the 9-90-90 plan works--one for the part less than or equal to 90 minutes and one for the part over 90 minutes).

   Pay as you go: total bill = **0.15 m**

   9-90-90: total bill = **$9 if m ≤ 90 and 9 + 0.90* (m-90) if m > 90**



Student Name: _____

On The Download 2

Subscription Plans - Handout

Instructions

The mePhone and mePhone2 don't work alone. You have to subscribe to a cell phone plan to use them. Here are details on the calling plans you can choose from:

Pay As you Go:
$0.15 per minute, no flat rate

9-90-90 Plan:
$9 per month gets you 90 minutes. For talk over 90 minutes, you pay $0.90 per minute.

1. Which plan is better? Well, it depends on how much you use your phone to make calls. Use a table graph, and/or equation explain which plan is better for each person:

   a) Talkative Ted who talks for 520 minutes or more each month.
   b) Taciturn Tina who only talks for 15 minutes per month.
   c) Typical Terrance who talks for 80 minutes per month.

2. Write an equation showing how much you will pay for each plan if you talk for *m* minutes each month. (Hint: you will need two "rules" to describe how the 9-90-90 plan works–one for the part less than or equal to 90 minutes and one for the part over 90 minutes.)

Handout #2