





Measuring Fastness

<p>Mathematical Goals</p> <ul style="list-style-type: none"> ● Isolate the attribute of “how fast one travels through space” or <i>speed</i> from other attributes such as “how fast one’s legs move” ● Understand that one quantity alone (such as time alone) is not sufficient to provide a good measure of “how fast one travels through space” – both distance and time are needed. ● Determine what quantities are needed to measure fastness. 	<p>CCSSM Standards</p> <ul style="list-style-type: none"> ● <u>CCSS.MATH.CONTENT.6.RP.A.1</u> Understand the concept of a ratio and use ratio language... <p>CCSSM Practice Standards</p> <ul style="list-style-type: none"> ● SMP2: Reason Abstractly and Quantitatively ● SMP6: Attend to Precision
<p>Mathematical Language Goals</p> <ul style="list-style-type: none"> ● Use a counterexample to explain why a single attribute does not determine fastness. ● Identify and explain why an idea is partially correct. ● Distinguish relevant and irrelevant attributes in a situation. ● Explain that distance and time are both needed to describe fastness. 	<p>MLRs to support Language Goals</p> <p> <u>MLR1</u>: Stronger and Clearer</p> <p> <u>MLR2</u>: Collect and Display</p> <p> <u>MLR8</u>: Discussion Supports</p> <p> <u>MLR10</u>: Act it Out</p>
<p>Student facing goals: I can determine the attributes that measure fastness.</p>	
<p>Lesson Glossary (Add to Co-Constructed Word Wall)</p> <p>Distance Time Attribute Stride length</p>	



Speed



Materials & Preparation

- Video
 - Record a video of two people walking (possibly doing funny walks). OR
 - <https://youtu.be/SRYtn0j5ccA> (Show first 30 seconds, possibly more, but the speed in miles/hour is revealed at 35s)
- Student Handouts
 - [Student Activity](#)
 - [Exit Slip](#)
- Stopwatch
- Measuring tape with distances marked
 - Put a number line tape before that is about 15-25 feet on floor in front of room
- Blank sheet of paper (8.5" by 11" is fine)

Math Notes For the Teacher

This is an introductory lesson. The main goal is to get students to focus on the relevant quantities that are used to measure “fastness.” Since this is an introductory lesson, the CCSSM alignment is in 6th grade. Nonetheless, this lesson is worth doing even in 9th grade because many students struggle with focusing on the relevant quantities when modeling situations involving speed. By the end of the lesson the goal is that students will focus on both distance and time when talking about speed.

- Students may initially focus on 1 quantity, such as time, when talking about speed (this is called univariate reasoning). For example, they might say that “the person who walks for the least time went fastest” or “they were the fastest because they finished first.”
- This lesson is designed to transition from univariate reasoning to focusing on 2 quantities changing together (this is called coordinating quantities).
- Prior knowledge can present a challenge to the teacher in this lesson [Many students “know” $D=RT$, but don’t really know what that means in terms of the quantities involved]. The lesson crucially depends on getting students to see that measuring fastness is not as simple as it may appear.

Introduction & Overview

1. Launch (10 min)
 - a. WODB
2. Explore Part 1 (10 min)
 - a. Initial ideas of how to measure fastness
3. Explore Part 2 (15 min)
 - a. Time alone



- b. Distance alone
 - c. Number of steps alone
 - d. Number of steps and time
 - e. Distance and time
- 4. Explore Part 3 (10 min)
 - a. Creating definitions of speed and how to measure speed
 - 5. Summary (5 min)
 - a. Exit Slip (5 min)




Phases of the Lesson

Notes for Teacher

Launch

Which One Doesn't Belong? (10 min)

- We are using this activity in an effort to introduce routines in the math club. Each day we will start with the same warm-up activity so students know what to expect when they walk in.
- Prompt: Here are four things that move. Which one doesn't belong? Give a reason to support your answer. Can you come up with a reason why each one doesn't belong?
- Use a **structured talk routine** such as assigned speaking turns to make sure each student shares in their group. 
- Possible answers
 - Cheetah does not leave a continuous trail, but the planes (contrail), snail, and car (tire marks) do.
 - Airplanes because they're in the air
 - The snail is slow; others are fast
 - Car because it needs a license plate (!?!?)

Which one doesn't belong? Why?

Each person will take a turn and explain.

Try to find an answer different from what other group members said.

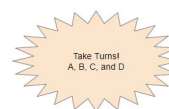


Slide 2

Which one doesn't belong?



Which one doesn't belong?



Slide 3

Explore Part 1

Option 1: Show the start of this video about how fast the fastest marathon runner, Eliud Kipchoge, ran <https://youtu.be/SRYtn0j5ccA>. STOP the VIDEO after about 30 seconds.

Option 2: Before class: Record a video. Show two people who are familiar to the students walking. For example,

Explore Part 1

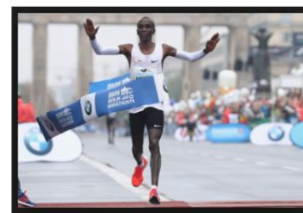


teacher and student or teacher and principal walking together across school. Camera moving with walkers. Walkers going approximately the same speed.

The main question we want to come from students is this: How fast is that person walking or running? A teacher can reply with a question: What information do we need to know?

Slide 4

That's Fast! But How fast?



Eliud Kipchoge winning Berlin Marathon

Slides 5

- Pass out Measuring Fastness Student Worksheet
 - Go over the main question, “How do we measure how fast someone runs”
 - Go through what you want them to do on the worksheet
- Use a think pair share **structured talk** routine
 - 2 min to Think + 3 min to Write
 - 3 min to share within groups (45 seconds each person)
 - 5 min to share as a class



Each group shares what they would measure and Teacher (or another student) records all ideas on the board. Emphasize that students should make no challenges at this point. Possible responses:

- a. Time (or how long it takes you)
- b. Distance (or how far you run)
- c. Number of steps
- d. Length of a step
- e. Distance and time
- f. Steps and time
- g. Step distance and number of steps



Measuring Fastness Classwork

Name: _____ Group _____ Date _____

1. Think of how you can measure how fast someone is going. Write a plan for what you would measure and how you would use those measurements.

Student handout question 1

Slide 6

Fastness

1. Think of how you can measure how fast someone is going. Write a plan for what you would measure and how you would use those measurements.



Gather Ideas

What measures fastness?

Slide 7



NOTE: If equations come up ($D = rt$, $D/r = t$, $Dr = t$, $T/r = d$), don't let students use formulas unless they can explain why they work. Ask:

- What does it mean?
- Could it be $dr = t$?
- Why divide?
- What units go with the equations (mph, hpm, ???)
- Is speed always in mph or whether it could be other things, (kmh, fps, etc.)
- Is 6 min. in 1 mile a speed?
- What exactly does r mean?

Explore Part 2

Running Races to explore ideas from worksheet 1



Explain that the class is going to test whether or not these ideas on the board make good measures of how fast someone runs. It is important that you actually try races to show what works and what doesn't.

You don't have to do the races in the following order, but start with single quantities first before going to two quantities. You also don't have to try everything, but try several single quantities, maybe until the class says to try two quantities and perhaps end with distance and time.

Time alone

Tell students that a volunteer student and you will run across the room. Each will run for the same amount of time. Either set the time or ask students what time they want to use. Get a volunteer runner. Ask for predictions: When we both run for 7 seconds, will be going equally fast, will student be faster or will teacher be faster? Maybe show of hands without explanations yet.

Ask for a volunteer time keeper. Then let the time keeper practice. For example, have the volunteer running start running and the time keeper has to say stop after 7

Try Out Ideas

	Notes
Attribute: _____	
Did it Measure Fastest?: _____	
Why or Why not? _____	
Attribute: _____	
Did it Measure Fastest?: _____	
Why or Why not? _____	
Attribute: _____	
Did it Measure Fastest?: _____	
Why or Why not? _____	

[Slide 8](#)



seconds. Teacher doesn't run yet. When you think the time keeper is ready, both run:

Student: travel for 7 seconds

Teacher: travel for 7 seconds (try to go slower)

Afterwards, ask students what did they notice? What happened? Why?

Distance alone

Same as above, but now fix the distance and mark it in the classroom. As a student to volunteer to run.

Student: Run 15 feet

Teacher: Run 15 feet (but try to go faster or slower)

What did you notice? What happened? Why?

Number of steps alone

Ask students many steps they would like each runner to take (e.g., 20 steps). Get a volunteer student. Maybe let him/her practice first and ask class to count his steps. Then maybe split class so half count student's steps and half will count your steps. Ask for predictions: Will both run equally fast, will student be faster? Will teacher be faster?

Student : 20 steps

Teacher: 20 steps (take baby steps, to go slower)

What did you notice? What happened? Why?

Number of steps and time (no distance)

Similar test as for steps but this time try steps and time. Volunteer will have to practice first.

Student : 20 steps in 5 sec

Student: 20 steps in 5 sec (go slower by taking small steps)

Share as a whole class

What did you notice? What happened? Why? What is being measured. (how fast legs do around)



Distance and Time

For this one you could first do it for you and the student. Ask students for a particular distance and time to try (e.g., 15 ft in 7 sec).

- Then given student a chance to practice. Will need time keeper. Take predictions. Run with teacher and student. Discuss what they noticed, what they think happened and why.
- They may want to test this; may not believe. Have 2 more students come up. Let each practice 15 ft in 7 sec separately. Then tell one to try to run fast and one to try to run slow (but they have to do 15 ft in 7 sec)
- Small group (5 min to write, 5 min to share)
 - In groups, have students come with their own definition of speed
 - Have them write it on a blank sheet of paper and be ready to share their definition to the class
 - Questions:
 - “What is fastness?”
 - “How do you measure how fast someone is walking?”
- Share as a whole class
 - Collect and Display

Explore Part 3

Defining Fastness

Ask students to rewrite their initial answer to Question 1



The goal of this activity is for students to refine their initial explanation based on what they have

Fastness

Think of how you can measure how fast someone is running. Write a plan for what you would measure and how you would use those measurements.

[Slide 9](#)



Summary

Notes and Closing

Summary

Ask a student to summarize what they learned by doing the races. Use talk moves to ask others to explain their ideas and/or revoice what classmates said.



Introduction of Speed

Let students know that there are different kinds of “fastness”. We can measure how fast someone’s legs move around. We can measure how fast one goes through space (e.g., how fast one runs across the room). Both are legitimate but they are not the same thing.

We are going to focus on the fastness through space in this unit and this type of fastness is called “speed.” So when you say the word “speed” you are talking about fastness of a body through space not how fast your legs go around.

And what you’ve discovered today is that both distance and time matter when we are trying to measure speed.

Exit Slip

Collect the exit slip to gather assessment data. The Exit Slip questions follow two popular formats from SBAC questions (react to someone’s thinking, select all that apply). This is not immediately important to highlight, but good for the teacher to know and consider so students have the opportunity to answer these kinds of questions.

Measuring Fastness Exit Slip

Name: _____ Period _____ Date _____

Cassie thinks if she knows **only the distance** someone ran then she can tell **how fast** they ran. Do you agree or disagree? If you agree, explain why. If you disagree, give a counterexample to show why Cassie’s reasoning is incorrect.

Student exit slip handout
[Slide 10](#)



Homework

This is a foreshadowing to the launch in the next lesson.
It is not necessary.

What information do you need to know to measure how fast someone runs? For each piece of information decide if it is "Required" or "Not Useful"

	Required	Not Useful	Why
The number of steps taken	<input type="checkbox"/>	<input type="checkbox"/>	
The height of the runner	<input type="checkbox"/>	<input type="checkbox"/>	
The total time run	<input type="checkbox"/>	<input type="checkbox"/>	
The age of the runner	<input type="checkbox"/>	<input type="checkbox"/>	
The total distance run	<input type="checkbox"/>	<input type="checkbox"/>	
The length of the runner's steps	<input type="checkbox"/>	<input type="checkbox"/>	
The direction they walked.	<input type="checkbox"/>	<input type="checkbox"/>	

Student homework



Name: _____ Group Number _____

Which One Doesn't Belong?

- Race Car
- Cheetah
- Snail
- Jets



Explanation: The _____ doesn't belong
because _____

_____.

Find a partner who has a different answer than you do. Write their answer here:

The _____ doesn't belong
because _____

_____.



Measuring Fastness Classwork

Name: _____ Group _____ Date _____

1. Think of how you can measure how fast someone is going. Write a plan for what you would measure and how you would use those measurements.

Notes

Attribute: _____

Did it Measure Fastness?: _____

Why or Why not? _____

Attribute: _____

Did it Measure Fastness?: _____

Why or Why not? _____

Attribute: _____

Did it Measure Fastness?: _____

Why or Why not? _____



Notes

Attribute: _____

Did it Measure Fastness?: _____

Why or Why not? _____

Attribute: _____

Did it Measure Fastness?: _____

Why or Why not? _____

Attribute: _____

Did it Measure Fastness?: _____

Why or Why not? _____



Think of how you can measure how fast someone is running. Write a plan for what you would measure and how you would use those measurements.



Measuring Fastness Exit Slip

Name: _____ Period _____ Date _____

Cassie thinks if she knows **only the distance** someone ran then she can tell **how fast** they ran. Do you agree or disagree? If you agree, explain why. If you disagree, give a counterexample to show why Cassie's reasoning is incorrect.

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Name: _____ Period _____ Date _____

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Measuring Fastness Exit Slip

Name: _____ Period _____ Date _____

Cassie thinks if she knows **only the distance** someone ran then she can tell **how fast** they ran. Do you agree or disagree? If you agree, explain why. If you disagree, give a counterexample to show why Cassie's reasoning is incorrect.



Measuring Fastness Homework

Name: _____ Group _____ Date _____

What information do you need to know to measure how fast someone runs? For each piece of information decide if it is “Required” or “Not Useful”. Then explain why.

	Required	Not Necessary	Why?
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The height of the runner	<input type="checkbox"/>	<input type="checkbox"/>	
The total time run	<input type="checkbox"/>	<input type="checkbox"/>	
The age of the runner	<input type="checkbox"/>	<input type="checkbox"/>	
The total distance run	<input type="checkbox"/>	<input type="checkbox"/>	
The length of the runner's steps	<input type="checkbox"/>	<input type="checkbox"/>	
The direction they walked.	<input type="checkbox"/>	<input type="checkbox"/>	

