**Bringing Writing to Science:**
**Improving Students Writing and Understanding of the Physics Unit**

by Whitney Graham, 2019 CTI Fellow
Wilson STEM Middle School

This curriculum unit is recommended for Science, Grade 7

**Keywords:** Speed, motion, reference point, frame of reference, motion, speed, velocity, constant speed, acceleration, deceleration, Speed, Acceleration, Distance, Time, Constant, Displacement, Rate, Acceleration

**Teaching Standards:** See Appendix 1 for Key standards addressing this unit.

**Synopsis:** This unit seeks to engage and help students understand the forces and motion unit. Specifically, this unit addresses the content-related graphs and vocabulary. Students will learn through a 4-part teaching sequence, followed by a 4-part writing sequence. Content vocabulary will be utilized throughout each part of the teaching and writing sequence. I designed this unit to specifically address the mathematics content, specifically the vertices and overall understanding on content-related graphs, so that students could access the science content.

*I plan to teach this during the next content unit to 80 students in Integrated 7th grade Science.*

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## Introduction

Rationale

The 7th grade Science curriculum is divided into 4 main units: Earth Systems, Structures and Processes, Forces and Motion, Structures and Functions of Living Organisms, and Evolution and Genetics. One of the things I enjoy about teaching Science is that it is a straightforward subject. The process of the heart pumping blood throughout the body, for example, though amazing and complex, I find easily understood with some steps and rationale. However, every year when we get to the Forces and Motion unit, the students struggle with almost every aspect of the unit.

I feel that one of the biggest confusions for students during the Forces and Motion unit comes when they focus on the lines in the center of the graphs, rather than on the vertices and overall on what the graph is showing. I feel that this comes in part from the students—wanting to find the end product or the answer-- rather than understanding what the graph is showing. Their focus on the line going up, down, or staying in place, I find attracts their attention and causes them to jump to conclusions about the graph.

I have tried typical teaching strategies such as, using multiple examples, using visuals to explain graphs, and creating a foldable for equations. However; nothing seems to have the impact for which I am hoping: a true, well-thought out understanding and explanation of each graph that they work with in class.

I have heard my colleagues from other subjects as well voice their concern over student difficulty with mathematics in various subject areas. For example, in a Social Studies class, students were asked to bring in a recipe using foods from a certain region. They were asked to double the recipe and then to divide the recipe ingredients in half. Both of these brought challenges and frustrations to both the teacher and the students. In my years of teaching, I have found that students, like many adults (myself included!) are very formulaic. They like their work to follow natural and easy patterns and steps. When asked to complete work that strays or challenges these steps, such as having to, for example, double a recipe with unlike denominator, they tend to lose confidence in their abilities

Unit Goals

My hope and my goal are that the implementation of research-based strategies will help my students to slow down, to focus on what it is they will be learning and presented with, and overall that they will have a better understanding of the graphs and equations presented to them in the Forces and Motion Unit. Secondly, I would like my students to gain a deeper understanding of content vocabulary through seeing content-specific vocabulary multiple times and in multiple formats throughout a lesson.

By increasing the amount of writing done by students in my classroom, I hope that their writing skills will improve. My longer-term goal is to use these teaching/writing strategies in the other Science units throughout the year and to share them with the other content-area teachers on my team and at my school so that they can implement them into their classrooms.

Student Demographics

Wilson STEM Academy Middle School is mid-sized Title 1 middle school located right near the Charlotte airport. It was originally Wilson Middle School, which closed in 2013, and then re-opened in 2017 as Wilson STEM Academy. From the total enrollment of 509 students, 380 students (74.7%) are African American, 87 students (17.1%) are Hispanic, 21 students (4.1%) are Asian, 10 students (2%) are white, 9 students (1.8%) are from 2 or more races and 2 students (0.4%) are American Indian.

There are 247 female students at the school (48.5%) and 262 male students (51.5%). There are 58 students with disabilities (11.4%) and 9 Academically Gifted students (1.8%). 13 students (2.6%) are McKinney-Vento, 44 students are English Learners (8.6%) and 21 students (4.1%) have a 504 plan.

Wilson utilizes blended or computer-aided learning through the VILS (Verizon Institute Learning System) program, has 1:1 student-to-technology ratio, and offers elective courses such as Design and Modeling, Robotics and App Creators. In terms of test scores, in 2019, Wilson, "…ranked worse than 94.9% of middle schools in North Carolina. It also ranked 27th among 29 ranked middle schools in the Charlotte-Mecklenburg School District."[i]

**Content Research**

My content and teaching are loosely based and guided from Betsy Rupp Fulwiler's book: "Writing in Science." I felt that this book, and lay-out, gave the framework to help me to create the most useable, practical and comprehensive answers to my own personal classroom needs as well needs that have been identified for classroom students in the greater scholastic community.

In an article by Evens and Houssard, *Categorizing pupils' written answers to a mathematics test question: "I know but I can't explain",* they illustrate the issues that students face as they are asked at the elementary level to express their thinking[ii]. Evens and Houssard note that it is a challenge for teachers to assist students in expressing what they know, also for students to express their ideas with precise language. This is why the vocabulary piece that I have added in this unit is important. It helps to address this issue without overwhelming students. Evens and Houssard also note the importance of discussion, so that students can see examples of good justification[iii]. At the end of the writing session students are given a chance to share and to hear from their classmates' examples of high-level thinking and justifications.

Additionally, in the "Common Core State Standards for English Language arts & Literacy in History/ Social Studies, Science, and technical Subjects," the authors describe the need for students in middle grades to begin using more formal language in speaking and writing, practice

precise communication, and become more aware of their audience.[iv] The step-by-step format of the teaching and writing section for students detailed below will allow students to practice formal writing and communication.

Finally, in her Doctoral dissertation, "Developing instructional guidelines for elementary mathematical writing," Madelyn Colonnese asserts that instruction needs to, "Provide students with opportunities to engage in a productive discussion to support their writing[v]," and that teachers should use discussion prompts as part of their implementation. She also suggests using writing frames in mini-lessons, incorporating sentence frames and sentence starters.[vi] I feel that the "Scientific sentence starters" will give students the opportunity and framework to reason in that mathematical way.

With those needs in mind, we begin simply with a student notebook. In"*Writing in Science,"*[vii] Betsy Rupp Fulwiler has four main components for generic notebook requirements. I will use as the 4 main components for every science lesson where I incorporate writing:

1. "Date, in numerals, on the first page of the entry.
2. Students write a focus or investigative question for each lesson (I may come up with this question and have students help to interpret it)
3. There is writing about each science lesson
4. Students write legibly, not necessarily neatly".[viii]

In addition, Fulwiler encourages teachers to have students write scientifically, using specific vocabulary, rather than to incorporate their feelings into their writing.[ix] Here, students would be given anywhere between 2-5 content specific vocabulary to incorporate into their writing.

My teaching will incorporate the 2 main session lay-outs that Fulwiler adds to the Appendix of her book: The Science Session and the Writing Session.[x] I have modified the sessions to incorporate the needs and pacing of my students, including adding a vocabulary piece, sentence starters, and changing the pacing of the lesson to have the writing session directly after the teaching and learning session. This next section below is an overview of the two sessions:

**Teaching and Learning, and Writing.**

Session 1: Content Specific Teaching and Learning

As recommended by Fulwiler, the teaching and learning sequence begins with a focus question. Next, she recommends engaging students in the 4 specific learning phases: Engagement, Active Investigation, Shared reflection, and Application. Each phase leads directly into the next phase to help support student understanding/build student knowledge. In this unit, students will actively investigate several graphs and through the multiple phases will be given multiple opportunities to be exposed to and to learn the focus vocabulary word for the lesson.

During the *Engagement* stage of the Science session, Fulwiler recommends teachers either, "…provide a question that directs the students toward what they should be thinking about as they explore with the materials or guide students in writing a question to investigate" (Fulwiler, p.

14). Based off of Fulwiler's suggestion, students would be given time to circle what they consider to be key words in the focus question. This process can help students to be focused in their writing and learning, and provides a common language for the class to be used in whole and small-group discussions and in the students individual writing.

Additionally, according to Fulwiler, "This process helps students focus on the question, teaches them to read a question carefully, and improves their reading skills." (p. 15). For my students, I would begin with simple, focused questions such as, "How is constant speed shown on a graph?" I envision short pre-lesson discussions about terms such as constant speed. (For example, "We know the speed is the rate at which something moves, so what would constant speed mean?")

For my students, I am adding an additional focus on a vocabulary term that would be used during the lesson. After the focus question is presented, the students are asked to circle words that they consider to be important in the focus question. The question would be the title for their notebook entry. At a higher level, students could use the investigative question to identify variables.[xi] I may also have the students add an investigative question following the sentence stem, "I wonder…" to begin having them engage with the lesson.

From here, during the "Engagement" phase of the lesson, the teacher models making tables, notes, or data entries.[xii] At the beginning of the unit, or at the introduction of a new graph, I envision this as creating a graph in front of the students, writing in an axis at a time, and then adding the line in the middle, noting the changes as the line moves. Later in the unit, I envision this as the teacher and class interpreting a graph together.

During the next phase, *active investigation phase*, students take notes or make illustrations about their own graphs, while the teacher works with groups to ask questions, model language and address misconceptions.[xiii] The Active Investigation phase recommended by Fulwiler reminds me of the traditional classroom teaching style. However, now students understand and have more focus as to what they are looking for or will be learning. During this time, students will not be writing a lot, but will be working with concrete materials, collecting data, recording their results, or making illustrations.[xiv]

Another component of the active investigation phases is that students are encouraged to talk to each other like scientists, and use words such as "data" or "evidence". I envision this as having conversational/scientific sentence starters that students hold and are encouraged to utilize in their discussions. They could be as simple as "The data shows…" or, "The evidence shows…". If written with general science language, they can be used from one lesson to another. These sentence starters can transition to the next phases, the shared reflection phase, and the groups can share out on how many times they used their "Scientific sentence starters."

This is followed by *shared reflection*: the class comes back together as a group to discuss their findings and results. Here would be another time to re-emphasize the vocabulary word or phrase, having students use the content specific vocabulary word in their answers. During the Shared Reflection phases, Fulwiler recommends that students, "Leave their desks and sit together in an area that is designated for class discussions."[xv] For my classroom, I have difficulty envisioning this with the space, as my classroom isn't large enough to have two separate sections. As an

alternative, I can see possibly going outside to picnic tables every so often for a shared reflection time, or having a small group of 3-4 students visit a small section of the classroom designated for classroom discussions. Many students have small "libraries" with a set of books and a rug, and this would provide good space for this purpose.

As I am beginning the lessons, I would keep the class together as a whole during shared reflection, to model what a shared reflection piece looks like. As I feel that the students understand and are participating in shared reflection, I would move to small group shared reflection. Shared reflection could also be done in pairs or groups of three, or possible even on technology. For example, if the students were working on a Google Doc, they could participate in a shared reflection through their comments. Either way, it is important that there is a set of concrete materials to reference so that students can make connections. Finally, as students become more used to this stage, they can advance to sharing other materials such as word maps or graphic organizers.

During the application phases, the students connect the general concept to the real world. I envision this as students giving examples of when they have seen examples like the ones from the graphs in their lives. For example, if the graph was a Distance/Time graph showing constant speed, they could give examples of when they have seen objects around them, or when they have moved at a constant speed. Our school is located directly next to the Charlotte Airport, so a great example that students could share would be: are the planes that fly directly overhead at a constant speed, or do they speed up or slow down as they fly overhead?

*The Writing Session*

The next session that directly follows is the *shared writing mini-lesson and independent writing*. Here, the students are given a chance to draw conclusions from the lesson; I would also have them reflect aloud or to a partner about their "I wonder" question from the beginning of the lesson. During the mini-lesson, the teacher con model specific type of writing, such as compare and contrast.

Given the number of English Learner students and Tier 1 academic intervention students I teach, I would probably rely heavily on sentence stems/ sentence starters for this session. (See below) Depending on the lesson, I would also use word banks to re-emphasize the content specific vocabulary. One additional layer for my EL (English Leaner) students, in accordance with the EL Plans, I would provide these students with key vocabulary words from the focus questions in advance in English and Spanish, along with visuals. This way they will have more success participating in or understanding the discussion, and will have a greater chance to learn during the lesson.

For example, from the first lesson, the vocabulary word would be "Speed," and some sentence starters for the students would be:

- Speed 1 was _____ m/h _____.
- Speed 2 was _____ m/h _____.
- A straight line on a distance-time graph shows _____ speed.

I will most likely hold the writing session directly after the Science session due to time restraints. The only other time I could envision completing the Science-writing session would be at the beginning of the next days' class.

The first step of the writing session is the *shared review*.[xvi] Here students are given a chance to provide explanations through questioning. For my students, since we are combining the subject lesson with the writing lesson, I would keep this section short and focus on the information that the students will be writing about.

Next is the *Shared Writing* stage. Again, I would probably keep this part quick (5 minutes or less) in the beginning and mainly use it to model the sentence stems for the students. As the students become more comfortable with their writing, I may begin modeling specific types of writing such as compare and contrast, writing in steps, or a formal writing piece.

During the *scaffolding* stage, all other information is removed so that students can focus just on writing. Typical scaffolding can look like this:

- Words from the question (topic sentence)
- "For example," (introduce data)
- "But" (introduce data from the other end of the data range)
- "Therefore," (introduce concluding statement)
- "I think this because" (introduce inferential thinking)[xvii]

"When students have learned how to provide evidence for their thinking, they do not need to use any scaffolding."[xviii] She also recommends that students are asked regularly, "What is another way we could write this?"[xix] so that they understand that the writing frame is just a place to begin.

Fulwiler also explains that the students should think of the audience as scientists, and included multiple resources for sentence frames for Observations, compare and contrast, useful words and phrases in Scientific writing, components of a scientific conclusion, data analysis and criteria for exemplary science notebook entries, among other things.[xx]

Finally, the students complete the *independent writing* phase, and utilize their sentence stems, content vocabulary and possibly a word bank to answer questions or draw conclusions in their Science notebooks.

Depending on the specific focus or sentence stems, the students would be engaged in either exploratory or informative/ explanatory writing.[xxi] Students can use the writing piece in two ways: the writing can help them to make sense of the content, the graphs in this case, or their writing can be used to explain why they came to the conclusions that they did.

For the exploratory piece, students may be asked specific questions about the graph, and then asked to explain their answer using evidence from the graph. This could also help them to clarify or get a good understanding of the lesson.

For the informative/ explanatory piece, students may be asked to describe different attributes of the graph and explain how each attribute affects the overall results that the graph illustrates.

**General Teaching Strategies**

Overall, I plan on implementing the 4 phases on each lesson as Fulwiler has recommended. Organization is important to me in my classroom, so I am going to directly show, and have the students record, each phase. In my classroom, I rely heaving on Google Classroom and Google Slides, so I may incorporate the classroom lessons or both the classroom lessons and the writing sessions into Google Slides, having students follow along with me on the slides during direct-instruction, and work at their own pace during the writing session. The typical note book/ Google Slide set up would look like:

*9/5/19 Focus Question: What does a straight line mean in a distance-time graph?*

*Underneath this, students may glue in their investigation paper, or record results of investigations.*

*Class results/ ideas*
*Sentence starters/ scaffolding/ conclusions*.

In general, if everything could fit onto 1-page, I think this would help with cohesiveness for the students. Also, students could use the left side of their notebook for a more interactive style, adding picture or information or asking questions.

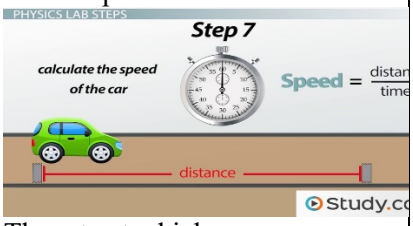
In addition, I will put a big focus on pre-teaching, using and encouraging the students to use content-specific vocabulary, as I know that this is an area in which my students struggle. I will most likely, as I mentioned earlier, develop a grading method for the discussions, to encourage students to move toward more academic discussions.

I also hope to add a testing component piece. I feel that so many of my students do poorly on tests because they fail to take their time, or to interpret the information given to them in a test setting. As we have tests and quizzes in class, I will add a part of the grading for use of strategies such as writing a focus question, circling key words, and having students write a conclusion for graphs and charts using sentence frames. Example: This graph shows _____because_____. Some of my English-Language Arts colleagues have successfully incorporated into their grading a portion for students who use Close Reading techniques, and I am hoping that this will translate with similar success in my classroom.

**Classroom Lessons**

7.P.1.3 Collect and organize data to show how the motion of an object changes in position over a period of time. Communicate and graph data showing how the motion of an object changes position over a period of time.

Science Session #1

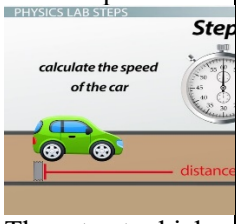
| | 1. Engagement | 2. Active Investigation | 3. Shared Reflection | 4. Application |
|---|---|---|---|---|
| Teacher | Focus question, "How is speed shown on a distance-time graph?"<br>Show: Speed<br>  <br>The rate at which someone or something is able to move | Create a class chart, add distance to the y axis and show how distance moves away from the 0.<br>Add time to the x axis and show how time is increasing.<br>Write the formula for speed and show how the slope of the line can change the speed.<br>Add 2 points to the graph, give students the formula for speed and have them calculate the speed at each point | Class discussion- Students use the word "Speed" to identify the speed at 2 different points.<br>Extension: If the speed was greater at the 2nd point, the person/ object was speeding up. Use this to introduce acceleration: Which includes an object speeding up, slowing down, or changing direction. | Class discussion: Where in your life have you seen something move at different rates? |
| Student | • Circle key words in the focus question<br>• Write a statement beginning with the words, "I wonder…" | • Create a distance/time chart with the class<br>• Use the S=D/T formula to calculate the speed at 2 points | • Participate in discussion<br>• Use "Scientific sentence starters" | • Answer questions using "The data/ evidence shows"<br>• Come to board/ to graph as needed |

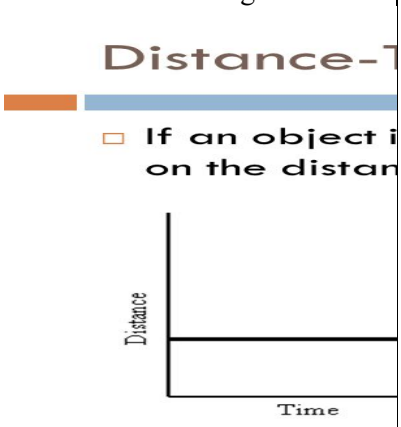
| | | | | |
|---|---|---|---|---|
| | | on the graph | | |

Writing Session

| | 1. Shared Review | 2. Shared Writing | 3. Scaffolding | 4. Independent Writing |
|---|---|---|---|---|
| Teacher | Quick review of data | Models sentence stems for graph:<br>"The vertices were…"<br>"Speed is a measurement of and ___."<br>"The speed at point A was …"<br>"The speed at point B was…" | Teacher provides sentence stems | Provide word bank: Speed, distance, time and work with students to answer sentence stems |
| Students | Written reflection, "The data shows…" | Give answers and explanations for sentence stems. | Students copy or glue sentence stems. | Students answer sentence stems. |

Science Session #2

| | 1. Engagement | 2. Active Investigation | 3. Shared Reflection | 4. Application |
|---|---|---|---|---|
| Teacher | Focus question, "Why is an object that is said to be stationary represented by a horizontal line on a distance-time graph?"<br>Show: Speed<br>  <br><br>The rate at which someone or | Create a class chart, add distance to the y axis and point at different distances.<br>Add time to the y axis and show how time is increasing.<br>Pick at distance on the graph (Ex. 2 meters) and show how something staying at 2 meters | Class discussion-<br>What is the distance at different points on the graph?<br><br>Application: Where have you seen something stay at the same distance and not move? | |

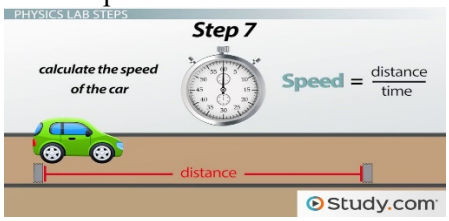
| | | | |
|---|---|---|---|
| | something is able to move | would not be moving.<br>  | |

| | | |
|---|---|---|
| Student | • Circle key words in the focus question<br>• Write a statement beginning with the words, "I wonder…" | • Construct distance time graph in notebook with the same distance throughout |

Writing Session

| | 5. Shared Review | 6. Shared Writing | 7. Scaffolding | 8. Independent Writing |
|---|---|---|---|---|
| Teacher | Quick review of data | Models sentence stems for graph:<br>"The vertices were…"<br>"Speed is a measurement of and ___."<br>"The distance at point A was …"<br>"The distance at point B was…" | Teacher provides sentence stems | Provide word bank: distance<br>Work with students to answer sentence stems |
| Students | Written reflection, "The data shows…" | Give answers and explanations for sentence stems. | Students copy or glue sentence stems. | Students answer sentence stems. |

Science Session #3

| | 1. Engagement | 2. Active Investigation | 3. Shared Reflection | 4. Application |
|---|---|---|---|---|
| Teacher | Focus question, "What types of things affect speed, velocity and acceleration of an object?"<br>Show: Speed<br>  <br><br>The rate at which someone or something is able to move<br>Velocity: Speed and direction<br>Acceleration: Any change in velocity; or any change in speed and direction.<br>Show video to illustrate acceleration: https://www.youtube.com/watch?v=eNjUOK8sJWs<br>• Show the 2 materials: 2 marble sizes and wooden planks for ramps<br>• Illustrate how to set up to calculate speed | Works with groups as they calculate speed using different variables: Large/ small marble, height of ramp | Class discussion- Students use the word "Speed," "Acceleration" and "Velocity" to report their findings.<br><br>Class chart:<br><br>Speed with large marble:<br>Speed with small marble:<br>Speed with high ramp:<br>Speed with low ramp:<br>. | Class discussion: What conditions caused the greatest acceleration?Where in your life have you seen something change its speed?<br>Did different variables effect the speed? |
| Student | • Circle key words in the focus question<br>• Write a statement beginning with the words, "I predict…" | • Record the speed of marble using 2-5 | • Participate in discussion | • Answer questions using "The |

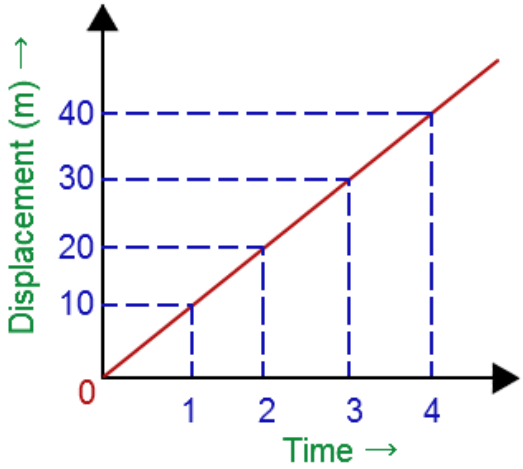
| | | | | |
|---|---|---|---|---|
| | | variables | • Use "Scientific sentence starters" | data/ evidence shows"<br>• Come to board/ to graph as needed |

Writing Session

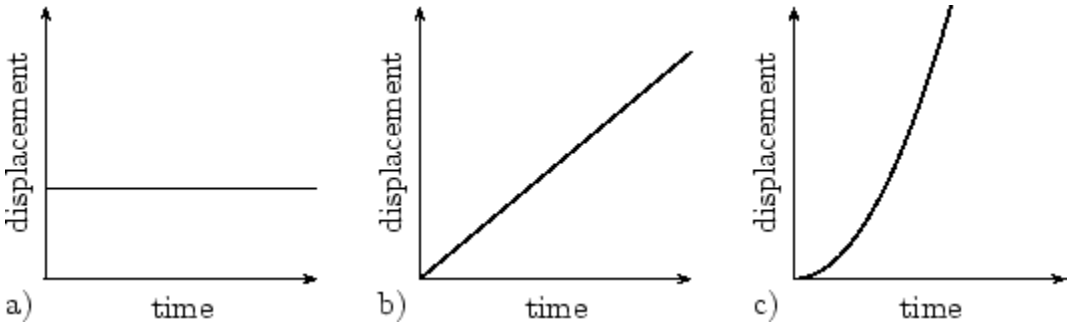
| | 5. Shared Review | 6. Shared Writing | 7. Scaffolding | 8. Independent Writing |
|---|---|---|---|---|
| Teacher | Quick review of data | Models sentence stems: "The conditions with the greatest acceleration were…" | Teacher provides sentence stems | Provide word bank: Speed, velocity, acceleration, variables<br>work with students to answer sentence stems |
| Students | Written reflection, "The conditions with the greatest acceleration were.." | Give answers and explanations for sentence stems. | Students copy or glue sentence stems. | Students answer sentence stems. |

**Assessments**

1. What does this graph show about an objects speed?




2. Which graph shows an object that is not moving?




3. Motion is a change in

A. Position over time
B. Speed over time
C. Velocity over time
D. Acceleration over time

4. Jenna knows that a friend runs 100m in 8s. She could use this information to calculate her friend's

A. Position
B. Motion
C. Speed
D. Acceleration

5. What is the formula for solving for speed?

_____

6. What is the formula for solving for time?

_____

7. What is the formula for solving for distance?
   _____
8. If a car travels 400m in 20 seconds, how fast is it going?

**Resources**
Materials for Classroom Use

Name _____

Speed Trials Problem: To calculate speed
Background Information: Motion is a change in position measured by distance and time. Speed is the rate of change in position. Speed combines information about how far an object moves (distance) with how long it takes to move that distance (time). Speed is the rate at which an object moves.
Speed = distance ÷ time
Distance and Time can also be calculated with these formulas: Distance = speed X time Time = distance ÷ speed

Materials: Stopwatch 1m board Wood blocks Toy car Calculator
Procedure: 1. Use the wood blocks and the board to build a ramp 2. Put the toy car at the top of the ramp, with the front wheels behind the edge of the board. 3. On the signal, release the toy car so that it rolls down the ramp AND start the stopwatch. 4. Stop timing when the back wheels of the toy car leave the end of the ramp. 5. Record the data. 6. Repeat the procedure for a total of 5 times.
7. Average the data. Describe SPEED in your own words: _____
_____ _____
_____ _____
_____ _____
_____ _____

_____ _____ Speed Trial 2 M. Poarch – 2003 http://science-class.net Data: Trial Distance (m) Time (sec) Speed (m/s) 1 1 2 1 3 1 4 1 5 1 Average 1 Questions: 1. Use your textbook to describe: a. Average speed

_____ _____ b. Instantaneous speed

_____ _____ c. Constant speed _____ _____ 2. How is instantaneous speed different from average speed?

_____ _____ _____ 3. If you drive 200 miles in 3 hours before stopping for 30 minutes for lunch and gas. After lunch you travel 150 miles in an hour and a half. What was your average speed for the trip? Show your work.

https://classroom.google.com/u/0/g/tg/Mzg1MjY1NTQ1NzJa/MzkxOTI2MjQ0MTBa#u=MTUwMjY2Njg2&t=f
This was a slide deck created and assigned to students through Google Classroom.

**Appendix 1:**

From the *North Carolina Standard Course of Study*

7.P.1 Understand motion, the effects of forces on motion and the graphical representations of motion.

Students will understand that motion is a change in position, and they motion can be shown on a graph.

7.P.1.3 Illustrate the motion of an object using a graph to show a change in position over a period of time.

Students will visually see how speed can be calculated using a distance-time graph. Students will also be re-viewing an re-enforcing the formula for calculating speed (S= D/T)

7.P.1.4 Interpret distance versus time graphs for constant speed and variable motion

Students will use graphs to see visual representations on constant speed and changing speed, and will be given the chance to calculate the speed at different points in time on a graph.

From the *College and Career Readiness Anchor Standards for Writing*

*Range of Writing: W.10.* Grade 7: Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline- specific tasks, purposes, and audiences.

**Bibliography**


Casa et. al 2016. Types and Purposes for Elementary Mathematical Writing: Task Force Recommnedations.
Details the four main pruposes to reason and communicate mathematically. Gives student examples of each type of writing in the classroom so that teachers can visualize the types of writing for their own classrooms. The appendix gives a useable list of possible forms of writing and audiences so that teachers can quickly implement some forms into their classrooms.

Colonnese, M. W. (2017). Developing instructional guidelines for elementary mathematical writing (Doctoral dissertation). Retrieved from http://opencommons.uconn.edu/dissertations/1503)
Breaks down specific type of mathematical writing into teacher-friendly suggestions to consider and techniques to try in their classroom. Written in short style with frames so that teachers can choose techniques to try in their classroom based on their own interpretation.

Evens, H. & Houssart, J. (2004). Categorizing pupils' written answers to a mathematics test question: "I know but I can't explain". Educational Research, 46(3), 269-282.
A more in-depth read. Introduces the premise that students are being asked at younger ages to give proofs and explanations for their answers in math classes. Breaks down mathematical writing in the classroom into 4 main phases: Launch, explore, discussion and summary. Gives examples of what these would look like in the classroom.

Fulwiler, Betsy Rupp. 2007. Writing in Science: How to Scaffold Instruction to Support Learning. Portsmouth: Heinemann.
A comprehensive guide of how to quickly and formulaically introduce writing into almost any curriculum. Breaks down sessions into a teaching session and a writing session, where students have specific time set aside to write and reflect on their learning. Gives good

practical suggestions such as starting with a focus question and using sentence starters. Includes DVD's to illustrate the lessons in action as well as how to provide meaningful assessments.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010b), Common core state standards for English language arts and literacy in history/ social studies, science, and technical subjects. Washington, DC: Authors. Retrieved from http:www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf
Gives the standards for writing, which build on each other from one grade level to the next. Breaks writing into research, range of writing, and production and distribution.

**Notes**

[1] (Fulwiler 2007) p. 22
[1] (Fulwiler 2007) p. 22
[1] (Fulwiler 2007) p. 22
[1] (Fulwiler 2007) pp. 156-161

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[i] 9 "Wilson Stem Academy," SchoolDigger. Accessed September 21, 2019, https://www.schooldigger.com/go/NC/schools/0297003468/school.aspx

[ii] (Evans & Houssard 2004)
[iii] (Evans & Houssard 2004)
[iv] (National Goveners Association.., 2010) p. 62.
[v] (Colonnese 2017) p. 6.
[vi] (Colonnese 20170 p. 6
[vii] (Fulwiler 2007)
[viii] (Fulwiler 2007)
[ix]
[xx] (Fulwiler 2007) p. 153- 154
[xi] (Fulwiler 2007) p. 15
[xii] (Fulwiler 2007) p. 14
[xiii] (Fulwiler 2007) p. 14
[xiv] (Fulwiler 2007) p. 17
[xv] (Fulwiler 2007) p. 17

al, Casa et. 2016. *Types and Purposes for Elementary Mthematical Writing: Task Force Recommnedation*

Fulwiler, Betsy Rupp. 2007. *Writing in Science: How to Scaffold Instruction to Support Learning.* Portsmouth: Heinemann.

2006-2019. *www.schooldigger.com.* Accessed September 21, 2019. http://www.schooldigger.com.

[xvi] (Fulwiler 2007) p. 20
[xvii] (Fulwiler 2007) p. 22
[xviii] (Fulwiler 2007) p. 22
[xix] (Fulwiler 2007) p. 22
[xx] (Fulwiler 2007) pp. 156-161
[xxi] (Casa 2016) p. 4

[xxi] 9 "Wilson Stem Academy," SchoolDigger. Accessed September 21, 2019,

https://www.schooldigger.com/go/NC/schools/0297003468/school.aspx
[xxi] (Evans & Houssard 2004)
[xxi] (Evans & Houssard 2004)
[xxi] (National Goveners Association.., 2010) p. 62.

[xxi] (Colonnese 2017) p. 6.
[xxi] (Colonnese 20170 p. 6
[xxi] (Fulwiler 2007)
[xxi] (Fulwiler 2007)
[xxi]
[xxi][xxi] (Fulwiler 2007) p. 153- 154
[xxi] (Fulwiler 2007) p. 15
[xxi] (Fulwiler 2007) p. 14
[xxi] (Fulwiler 2007) p. 14
[xxi] (Fulwiler 2007) p. 17
[xxi] (Fulwiler 2007) p. 17

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Fulwiler, Betsy Rupp. 2007. *Writing in Science: How to Scaffold Instruction to Support Learning.* Portsmouth: Heinemann.

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[xxi] (Fulwiler 2007) p. 20
[xxi] (Fulwiler 2007) p. 22
[xxi] (Fulwiler 2007) p. 22
[xxi] (Fulwiler 2007) p. 22
[xxi] (Fulwiler 2007) pp. 156-161
[xxi] (Casa 2016) p. 4