Take Your Places at the Starting Line

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This curriculum unit is recommended for:
Science/ Grades 1-3

Keywords: force and motion, scientific method

Teaching Standards: See Appendix C for teaching standards addressed in this unit.

Synopsis: Force and motion can be a difficult area of the science curriculum to explain to young learners. Often, curriculum written on this particular topic may be somewhat dry and involve minimal hands-on experimentation. Originally written for a first grade classroom, this unit was created in order to make force and motion come alive for students. In addition to mastering grade level vocabulary terms, children will be designing four types of cars running on balloon power, a reaction between utilizing Diet Coke and Mentos, a reaction of baking soda and vinegar, as well as on solar power. Students will document each experiment conducted and will use force and motion vocabulary when making observations. At the same time students are mastering force and motion curriculum, students will be fully engaged in the scientific process and learn the correct steps in the scientific method. This unit also includes multi-subject area integration through the inclusion of measurement and graphing. To incorporate language arts standards, students will be journaling each step of the process. If you are looking for an engaging way to introduce the scientific process and basic physics concepts, this unit is a great addition to your science curriculum.

I plan to teach this unit during the coming year in 2013 to 23 students in science for first grade.

Take Your Places on the Starting Line
A Force and Motion Unit
Elizabeth Lehman

Introduction

I am currently a first grade teacher at John M. Morehead S.T.E.M. Academy which is Charlotte- Mecklenburg's only S.T.E.M. (Science, Technology, Engineering, and Mathematics) based magnet school. As a teacher, my goal is to make science come alive for my students. Nothing is more rewarding than watching their faces light up with excitement as they delve into new science material. This curriculum unit is designed to introduce young scientists to force and motion through the use of experiments and demonstrations. As the unit progresses with each activity, students will be constructing four different cars and testing different methods of powering these cars. In this unit, students will be comparing the travel distances of each of the cars. At the same time, students will familiarize themselves with grade level vocabulary.

To give a little more background on my current school environment, our school is home to nearly 1,100 students ranging from kindergarten to eighth grade. We have an extremely diverse student body, but the consistent infusion of scientific principals into data based instruction is a uniting characteristic of each grade level. S.T.E.M. integration is used in every subject area. Science curriculum is allotted 45 minutes three times a week in our grade level schedule, so activities are paced in accordance with this type of time schedule.

In my class, I currently have 23 students. Overall, I have approximately 7 students performing above grade level, 13 students on grade level, and 3 students who are slightly behind. My classroom is also home to six students with English as a second language. Four of these students receive services to help them work at grade level standard. In order to make student collaboration as successful as possible throughout my unit, I would like students to work in groups of mixed abilities with five or six students in each group. . All of my students are highly engaged in scientific experimentation of any kind; they love to have an active role in hands-on discoveries. My class is a very lively group of six and seven year olds so, in order to teach effectively, lessons must be highly engaging and take place at an appropriate pace.

Our current science curriculum includes components of force and motion. To make this unit come alive for my students, I would like to fuse force and motion concepts with the scientific process. One of my primary goals with this unit is to continue to fuel my students' interests in science as a whole. Despite the unit being written with a first grade classroom in mind, the activities detailed are easily transferrable to a classroom of students slightly younger or older.

At our school each year we hold a S.T.E.M. Fair. In the third grade and beyond, student projects are developed individually. However, in grades kindergarten through second, this competition is held between classes. Each of the six classes in each grade level competes against one another. The product of this curriculum unit, the production of the four cars and the comparisons drawn between these cars, will serve as our class's entry in the S.T.E.M. Fair. However, with or without a science fair, the scientific exploration utilized in this unit would be a great opportunity for hands-on exploration in the classroom as well.

Learning Objectives

After the completion of this curriculum, students will come away with an understanding of both force and motion concepts and the scientific process as a whole. Students will be able to explain each step necessary to conduct an experiment as a scientist. Also, students will understand the concepts of push, pull, force, and position as these are large parts of the first grade science standards.

Students will construct cars propelled by either the air exiting a balloon, a baking soda and vinegar reaction, a Mentos and Diet Coke reaction, or solar power. Thus, each of the four cars my students will be creating within this unit will be moved in a very unique way. Through these experimentations, students will develop an understanding of force and motion as well as push and pull vocabulary. Students will use these words to effectively describe what is happening throughout their discoveries. Students will be expected to use these words accurately in their descriptions and their recorded observations. The idea of friction will also be introduced, highlighting the types of surfaces that would produce the greatest amount of friction.

Students will be testing each of these cars in order to find which car is able to move the farthest using its specific source of force. I will integrate mathematics into this unit by teaching students to measure using standard units of measurement. As dictated by common core curriculum, students are not expected to be able to measure in standard units at the first grade level. In order to make this process as painless as possible, students may be given pre-cut square feet to use to measure the distance that each car travels or use another set unit which allows for measurements to be rounded to the nearest half unit. They will be able to order the measurements from least to greatest. Students will then transfer measurements collected into a data table, and eventually into a bar graph in order to visually compare the cars. Students will be able to explain the information displayed in their graphs to others. Graphing and data collection are part of common core curriculum standards for this grade level as well.

This curriculum unit is filled with activities designed to take approximately four to six weeks to complete. Through these activities, students will become masters of the scientific process. In particular, they will be able to make predictions, describe materials, understand the sequence of the procedure, record observations, and formulate a conclusion. Students should be able to communicate with others what they are doing and why they are doing it. These ideas will be documented in students' S.T.E.M. Fair journals.

Furthermore, despite the fact that students understanding the difference between a physical and a chemical change is not a requirement of the common core curriculum until the second grade, I would still like my students to come away with a basic understanding of this idea. They should know that the car moved by the power of air being expelled from a balloon is an example of a physical change, while the other three cars demonstrate properties of a chemical change. This is a foundation students will be able to build upon in the future.

Overall, this unit will aid students in developing an understanding of force in motion concepts as well as the scientific process through the creation and testing of the cars. Students' interest in science will be sparked and the unit plan will integrate both mathematics and language arts standards in the context of a very interesting scientific discovery.

Background

If this curriculum unit is carried out with younger students, as it was designed to be, it is not necessary for students to have a very in-depth idea of why the physical and chemical reactions happen the way that they do. However, it is helpful for the teacher leading the unit to be somewhat versed on details behind the reactions. Also, it helps to have a general understanding of the history behind these types of reactions. The following is a breakdown for the unique background of each of the car designs.

Balloon Car

The balloon car is created by simply attaching a blown up balloon to a base car and then quickly letting the air out of the balloon in a way so that the car part is forced forward. This force/movement of this car design is a simplistic example of Newton's Third Law of Motion which states that, "for every action there is an opposite and equal reaction.[1]" For the balloon car, the action is the air escaping from the balloon and the reaction is the forward movement of the car. Also, the principles of the conservation of energy are at work as the potential energy, the elastic material of the balloon, and the balloon filled with air, is transformed into the kinetic energy of the moving car.[1] When the balloon is completely depleted of air, the car will come to a rest.

Mentos and Diet Coke Car

The movement of this car design is caused by a terrific reaction between Mentos Mints and Diet Coke being suddenly combined while attached to a car base. This reaction will create a foamy geyser of liquid which will shoot the car forward. In some circles of scientists it is debated whether the reaction between Diet Coke and Mentos is physical or chemical.[3] The reaction occurring in this demonstration is somewhat complicated. It is caused in part by the disruption of water molecules. The rough coating of the Mentos candy has a high amount of surface area which allows bubbles to grow rapidly. The low surface tension of the aspartame infused Diet Coke also allows for larger reactions than would be produced with regular coke. Also, because Mentos mints are a fairly dense candy, they will sink quickly into the Diet Coke causing even more bubbles to be created.[2]

The propulsion is caused by an exothermic reaction between Mentos Mints and Diet Coke in which leads to the movement of the race car. The reaction between Mentos and Diet Coke results in the formation of CO_2. CO_2 or carbon dioxide in this reaction forms in a gaseous state or form; as more gaseous material is made it becomes compressed in a fixed vessel and the vessel is pressurized. Due to the fact that the container, which holds the reaction, has a certain volume or allowable space for the reaction to occur, only a certain amount of CO_2 can be formed in the vessel before the pressure inside increases and moves beyond an equilibrium point. As more and more CO_2 is created due to the reaction, the pressure inside the vessel rises to a level beyond that of the atmospheric pressure. At this point, gas is released from a constricted opening forming a motivating force that overcomes the friction between the wheels of the car and the ground, moving the car forward. As the car moves, CO_2 continues to be produced but soon all the reactants will be consumed, the CO_2 pressure will reach an equilibrium point with the atmospheric pressure, and the car will begin to slow down and eventually stop. To maximize the efficiency of the cars movement, i.e. going farther, the amount of diet coke in the vessel is close to full but not completely, to allow room for the reaction to occur and gas to be produced.

As this car is being constructed, it may be appropriate to touch on, or at least for the teacher to understand, the link between the propulsion of this car by the reaction between Diet Coke and Mentos and the way rockets are launched. Similarly, when rockets are launched, the propellants are mixed together in a confined space and released at high pressure through a nozzle. Similar to the reaction between baking soda and vinegar, both reactions are examples of Newton's Third Law of Motion. As the chemical reaction product is ejected from the vessel, the car is thrust forward.[9]As far back as 400 BC, Aulus Gellius, a Roman, wrote about a Greek named Archytas who created a rocket in the shape of a wooden bird which was propelled on wires by steam. While this was still an example of Newton's Third Law of motion, this type of reaction was not even given a name until the 1600s. Although rocketry has evolved greatly through centuries and centuries of experimentation, it is important to realize how far back these concepts date.[10]

Solar Powered Car

For this car design, students will observe an example of the photovoltaic effect because a simplistic solar panel will convert solar energy into electrical energy which can be used to operate a small car motor. Photovoltaic materials have been used as far back as the 1800s and can be observed today in many commonly used materials.[4] It is important to highlight these devices in the curriculum unit as the car is constructed in order to make connections between the demonstrated science and items that students are already familiar with. This gives students authentic examples.

Photovoltaic cells, or PV cells as they are often called, can reflect, absorb, or allow light to pass through when shone on the cell. However, only the light that is absorbed is used to generate electricity. Energy from the absorbed light is then “transferred to electrons in the atoms of the PV cell semiconductor matter.”[11] Electrons then leave their normal positions and enter the electrical current. From there, the PV cell transfers the current to an external electrical device.[11] For this particular experiment, the external device is the car motor.

Baking Soda and Vinegar Car

Somewhat similar to the Mentos and Diet Coke car, the baking soda and vinegar car is moved when baking soda and vinegar are combined, attached to a car base, and the reaction produces a geyser composed of both liquid and gas through the small nozzel. This is an example of an acid-base reaction with vinegar (containing acetic acid) being the acid and baking soda (sodium bicarbonate) as the base. When the two combine, both are neutralized and carbon dioxide is produced. The chemical formula for this reaction is[11]:

$$NaHCO_3(s) + CHCOOH(l) \rightarrow CO_2(g) + H_2O(l) + Na+(aq) + CH_3COO\text{-}(aq)$$

As with the Mentos and Diet Coke Car, the vessel containing the chemicals has only fixed amount of the space in which the carbon dioxide is increasing and pressure is rising. When the container can finally take no more pressure, the propellants are released from the container through the neck of the bottle. This then forces the car to thrust forward. When the bubbles finally stop forming, the car stops moving, and this is a physical sign that the reaction has come to equilibrium.[5] As mentioned before, this particular car design is an excellent example of Newton’s Third Law of Motion.

Teaching Strategies

While some of the reactions will have to be carried out as teacher demonstrations with young students, it is important to have the children as involved as possible through the entire process. There should be enough materials that students can work in small groups to create at least part of each of the car designs. Also, teachers should constantly keep in mind that the primary objectives of the curriculum unit are to introduce students to the scientific process, develop basic concepts for force and motion vocabulary, and teach students basic measuring and graphing skills. These objectives should be constantly put into student friendly terms and reiterated as often as possible. Furthermore, even though it is not one of the foremost objectives of the unit, writing and literacy skills should be integrated into every subject throughout the primary school years. With this in mind students must be reading and recording procedures and other parts of the experiment process. In order to fully explain this, teaching strategies have been broken into several subcategories.

S.T.E.M. Fair Journal

During the curriculum unit, students will be studying the scientific process. In particular, students will focus on the materials, hypothesis, procedures, observations, and conclusion portions. Students will be recording each of these components in a S.T.E.M. Fair journal. Since students at this age vary greatly in their writing capabilities, some students will be writing their observations independently while others will need to rely heavily on teacher modeled examples. Students should be expected to work neatly and understand why particular sentences are put on particular pages. Students will understand the basic terminology of the scientific method.

Vocabulary

Since mastery of the force and motion vocabulary is one of the key objectives of the unit, there will be several introductory activities used to give students some of the basic definitions. Students will first practice push/pull songs written to the tune of popular nursery rhymes. Students may also practice acting out the difference between push and pull using simple wooden blocks. Lastly, students will make four-flap flipbooks defining the words: push, pull, force, and position. Definitions may be made using either words or pictures depending on the writing level of the students participating. Students should work on these flipbooks as independently as possible in order for the teacher to obtain an accurate picture of student understanding.

Literary Integration

Throughout the unit, I will be integrating several children’s books in order to drive home vocabulary definitions as well as authentic examples of how force and motion can be seen in the world around us. One of the possible titles to use would be *Sheep in a Jeep* by Nancy Shaw. In conjunction with an interactive readings, scaffold questions will be posed to the students for classroom discussion. Also, as a class, students may create a T-chart linking instances of force and corresponding motions. Not all elements of the curriculum unit involving literacy need to put into science instruction time; it is very easy to incorporate these titles into Read Aloud time or use as part of a Balanced Literacy Program.   Please refer to the "Students Reading" sections of the curriculum unit for a full list of possible children's books titles, as this type of T-chart may be used in conjunction with several of the children's book titles listed.[6]

Interactive Websites and Possible Video Clips

One of the best ways to hook students' attention and get them to grasp content concepts is through the use of a short video clip and interactive websites. In my classroom, I like to model the use of these technology add-ins in a whole group format. Then, I will allow students to explore online references freely during centers. One of the best websites I have found for promoting different types of scientific exploration is www.stevespanglerscience.com. This website contains options for searching different kinds of classroom experiments as well as brief video clips of various science experiments which are fast paced enough to fit several clips into a twenty minute center rotation, but still thorough enough to contain several components of the scientific process. For force and motion links, BrainPop Jr. has clips and corresponding activities on this subject.[8] Also, BBC's website contains a portion where student can set up different force and motion trials using various degrees of push and pull on a track.[7]

Measurement and Graphing

According to the first grade common core standards, measurement and data collection are integral parts of the curriculum. After each of the cars has been built, students will need to measure the distances they traveled. Since students at this grade level are not typically familiar with standard units of measurement, another method of measurement may be necessary. In my classroom, I will be asking students to record distance data by counting the number of floor tiles the car is able to travel over. As it happens in my case, these square floor tiles are 12 inches in length. Students will record measurements to the nearest half tile. The cars will be built one at a time and tested one at a time; so as each car is tested, measurements will be recorded on a simple data chart. After each car has been tested and the data chart is complete, students will create both a bar graph and a line graph to display data. At this developmental stage, students will need graph basics to be set up for them, such as units and x and y axis labels. Students should strictly be concerned with graphing the data they collected.

Classroom Progression of Activities

This unit is designed to take approximately ten 45 minutes to one hour lesson blocks in order to complete. The actual number of weeks the curriculum unit will take for a class to complete may vary greatly depending on the number of hours allotted for science instruction in the school's schedule. The following subsections are a breakdown on how to complete the unit in a meaningful chronological order. However, as with anything involving teaching, adjustments may be required.

Days 1-4: Introductory Activities

Several activities will be used to give students the appropriate background in both force and motion concepts and the scientific method.

Day 1: Website Exploration and Vocabulary Flipbooks

I will demonstrate an example of push and pull and will model the appropriate use of BBC's interactive push/pull website.[7] Students will also view the Brain Pop video and use interactive links for online activities (see references in interactive website section) Students will hold a classroom discussion of the concepts using the guiding questions: What is the difference between a push and a pull? What words can you use to describe where an object is located? How many ways can you describe where something is? Use as many position words as possible. What is a force? Students will use the information generated from this class discussion to create a vocabulary flipbook with four flaps. Students will create verbal definitions and illustrations explaining the meaning of force, position, push, and pull. This flipbook is attached in the appendix.

Day 2: Push Pull Scavenger Hunt

The students and I will practice singing the push and pull songs written to the tune of popular nursery rhymes. Then, we will create lists of items requiring a push or pull to move, and it will be reiterated to students that both pushes and pulls are examples of force. Students will then be allowed to freely explore the classroom in order to develop a list of items or possibly sketches of items they have found that require pushes or pulls. If iPad or other technological devices with a camera are available for your students to use, students could have the option of creating a photo-journal utilizing these items.[8]

Day 3: Push and Pull Picture Sort/Sheep in a Jeep

The teacher will do a brief review of vocabulary and definitions using well-created students flipbooks to prompt responses. Then students will be given a picture sheet with examples of different pushes or pulls (i.e. a batter swinging a bat, a doorknob, a wheelbarrow, etc.). They will create a T-chart for organizing these pictures, and then sort the pictures into pushes and pulls. Students will complete this activity independently, and answers will be reviewed as a whole class.

Students will also read the children's book *Sheep in a Jeep* and cite examples of pushes and pulls found within the text. The class will create an anchor chart as a reference for the future, using it to help name the forces demonstrated in examples.

Day 4: What it means to be a Scientist

Today, the idea of the scientific method and what it means to be a scientist will be introduced to the students. First, I will have the students draw an illustration of what they feel a scientist does. You may wish to have students add a few sentences to their illustrations. After completing illustrations, I will allow students to take a gallery walk of the classroom to see what other students have depicted. Then, I will call students to the carpet to read the book *What is a Scientist?* by Barbara Lehn. This book takes students through each of the elements of scientific discoveries and the responsibilities a scientist has. After the story, I will ask students to draw comparisons between their illustrations and the scientists in the book. Next, I will explain to students that over the next week, we will become the scientists and go over the premise of the S.T.E.M. fair and our project. Lastly, we will set up our S.T.E.M. Fair journals into sections and decorate the front covers.

Day 5-8: Car Assembly

For each car the students assemble, a similar procedure will be used. Students will create a list of materials necessary to build a car. Then, we will have a class discussion and students will generate individual predictions for how far the car will travel. Next, we will create a brief list of procedures for assembling and testing the car. I will assemble the cars most of the way for the students, but will leave the last few steps for students to complete while working in groups. Finally, students will test the cars and measure and record how far the car actually travels. The balloon car and the solar car the students will be able to test independently. However, because of the timing issues involved in both the baking soda and vinegar car and the Diet Coke car, I will be helping students test these cars. As mentioned in the strategies section of the unit, students will be using square feet tiles or pre-cut poster board and estimating distance traveled to the nearest half unit. More specific notes for each day of assembly are listed below:

Day 5: Balloon Car

Students will be testing their balloon cars and measuring the distances each of these cars traveled. Students should discuss and record materials used, and predict how far the car will travel. Several options of cars are available for purchase through science websites. In testing for this unit, I purchased a Balloon Car kit from *Toysmith*. Any kit would work, and most balloon car kits can be purchased for fewer than twenty dollars. If it is possible, there may be a way to produce the same product by yourself if you can find a way to attach a balloon to a toy car. In my class, we will be completing this project in partners. Speaking from experience with balloons, be sure that students are not directly blowing into the same balloons.

This is the only car design in which a physical change, not chemical reaction, is causing the car to move, so touching on the difference between a physical and a chemical change may be helpful at this point in the curriculum unit. While it is not expected that students will master these definitions at this grade level, introducing these concepts now will work to the students' advantage in the future.

Day 6: Mentos Car

For this car, I purchased a set from *Be Amazin*g. Students will again record materials used and their distance predictions. I will use this particular car as either a demonstration with a whole class or in larger groups of students with at least one more advanced student in each group. This becomes necessary because the quick timing of the reaction which propels this car is problematic. As soon as the Mentos hits the Diet Coke the reaction will instantly begin, so the car must be ready to be set into motion at that time. Once again, students will be recording materials, predictions, and distance traveled. For teacher demonstration purposes, it is noteworthy that the same reaction will occur if fruit-flavored Mentos candies are used!

Day 7: Baking Soda and Vinegar Car

The sample car I bought for this experiment was made by *Scientific Explorer*. This car was slightly difficult to put together and fragile even after construction was completed. Unless you are able to locate or make a more solidly constructed model, I would use it as a whole group because of its fragile design and the fast paced execution necessary with the salt and vinegar. Students will continue to fill in their S.T.E.M. Fair journals even if the teacher is leading the experiment.

Day 8: Solar Car

For the solar car, I purchased the *Solar Car Easy Assembly Kit* through Amazon.com. As with the other cars, this kit is able to be purchased for fewer than twenty dollars. The construction of this car is fairly easy, if the funding is available to purchase enough cars, I would buy enough for students to work in groups of three. Again with this design, students will be following each step in the scientific method with this car. Students will be able to complete their data charts on the same day. Because of the nature of this car, I will be discussing the possibility of using larger models of solar cars for actual transportation in the future. We will also discuss how this fits into "Going Green" which is a phrase many students became familiar with in kindergarten. Students will see that in contrast to the baking soda and vinegar cars and the Diet Coke and Mentos cars, the energy created by the photovoltaic solar cell is not easily depleted. As long as the car has the power of the sun, the car will continue rolling. After generating classroom discussion, students should come away from this learning activity realizing the benefits of a replenishing energy like sunlight versus a liquid chemical fuel.

Day 9: Graphing

Students will take data collected in a simple chart and convert this chart into, first a bar graph and then a line graph. It will have to be explained to students what the difference between the two graphs is. If a graphing unit has already been covered in mathematics instruction, best practice for this exercise may be to have students attempt each of the graphs individually first, have the teacher complete a version as a class, and then have students make revisions to the graphs they created on their own. If graphing has not yet been taught, I would first model this graph with the students and allow them to copy my graph onto their own papers as necessary.

Day 10: Conclusion Discussion

As part of the wrap up for this unit, a full lesson should be taken to discuss what each of the students has learned through the unit. Scaffolding questions should be used to prompt students on the differences between each of the cars created. Eventually, a majority of the students should be able to describe the difference between a chemical and physical change. Students should also be able to identify any possible “errors” we made in constructing each of our cars and the effect they would have on our data. Within this discussion, the type of surface each car was operated on should be noted and linked back to students’ understanding of friction. The teacher may wish to refer back to vocabulary flipbooks the students created earlier in the unit. To add to this discussion, I would like students to reflect on how the car’s overall weight could possible effect the distance it is able to travel. Again, students should be able to utilize grade level force and motion vocabulary in this discussion. Finally, I will also take this lesson as an opportunity to celebrate student achievements and to showcase some of the work done by each of the students (i.e. unique S.T.E.M. Fair journals done particularly well). Students will share, and I will award participation certificates to students who exhibited leadership skills in curriculum unit discussion as well as group work with the cars.

Safety and Classroom Clean-up

Of course when working with young students, safety is a genuine concern. Although the chemicals used in these experiments are fairly mild, proper chemical disposal should be taken into consideration. Weather permitting, I would recommend doing all of these experiments outdoors. The solar car will not work without direct sunlight so an outdoor setting is a nonnegotiable for this particular car design. Furthermore, both the baking soda and vinegar car and the Mentos and Diet Coke will spray reactants as the car moves forward. Plenty of water should be used in order to properly clean up. Also, students working directly with either of these cars should be sure wear safety goggles as a precautionary measure.

Classroom Materials List

Mentos and Diet Coke Car Kit (produced through Steve Spangler Science and Be Amazing Toys)/ group
1 Liter Diet Coke/ group
1 Roll Mentos Mints/group
1 Large-sized Balloon/ group
1 Small Toy Car with attachments for balloon/group
2 ½ Tablespoons of Baking Soda/ group
1 Liter of Vinegar/ group
Solar Power Car Kit (including solar panels, connectors, and basic car kit)/group
S.T.E.M journal/ student
Force and Motion Vocabulary Flipbook/ student
Handouts for push and pull picture sort (see appendix B)

Conclusion

Overall, this unit is sure to produce high student engagement. Students are sure to develop and understanding of the scientific process through the use of student directed learning activities. Students will be excited and involved in each step of the experiment. They will formulate a hypothesis, sequence procedures, record observations, and generate a conclusion. Students will master grade level force and motion vocabulary and gain an understanding of why each of the cars was able to move forward. Furthermore, the unit includes science, mathematics, and literacy integration. At the conclusion of this unit, students will come away from this unit having had an authentic example of the scientific method as well as an understanding of common core required material.

Teacher Book List

Graham, John, and Jars David. Le. Science: Forces and Motion. New York: Kingfisher, 2001.
This text details 40 hands-on experiments and activities for students to try relating to force and motion curriculum.

Robertson, William C. Stop Faking It!: Finally Understanding Science so You Can Teach It. Arlington, VA: National Science Teachers Association, 2002.
Robertson's text will tell you absolutely everything you need to know about basics laws of physics and related demonstrations so you can properly teach a well-rounded unit.

Tocci, Salvatore. Experiments with Motion. New York: Children's Press, 2003.
This excellent text lends itself to the needs of both teachers and older students. It both explains the content and gives examples of several relatable experiments.

Reading List for Students/ Including Read Aloud for Parents

Lehn, Barbara, and Carol Krauss. What Is a Scientist? Brookfield, CT: Millbrook Press, 1998.
This book is written in a text that students should easily be able to comprehend and possibly read independently which explains what it means to be a scientist including many of the necessary steps in scientific exploration. Photographs of experiments are given with each process explanation in order to give students authentic examples.

Llewellyn, Claire, and Simone Abel. And Everyone Shouted, "Pull!": A First Look at Forces and Motion. Minneapolis, MN: Picture Window Books, 2005. \
This book would be particularly useful for very young students or students who may struggle with on-grade level work. This is the story of a farmer and his animals' trip to the market and the struggles they have in relation to force and motion on the way.

Stille, Darlene R., and Sheree Boyd. Motion: Push and Pull, Fast and Slow. Minneapolis: Picture Window Books, 2004.
This picture book is full of colorful illustrations explaining the concepts of force, push, pull, gravity, and inertia in a way young scientists are able to understand.

Mason, Adrienne, and Claudia Dávila. Move It!: Motion, Forces and You. Toronto: Kids Can Press, 2005.
This a literacy resource containing many hands on activities to inform readers on force and motion basic physic concepts.

Adams, Diane, and Kevin Luthardt. Zoom! Atlanta, GA: Peachtree, 2005.
While documenting a little boy's adventure on a rollercoaster ride, this book also introduces students to basic force and motion concepts.

Shaw, Nancy, and Margot Apple.Sheep in a Jeep. Boston: Houghton Mifflin, 1986.
Please see literacy integration section for full activity details on this particular book.

Interactive Websites for Students and Teachers

"BBC News- Schools Science Clips- Forces and Movement." BBC News. Accessed October 7,
2013. http://www.bbc.co.uk/schools/scienceclips/ages/6_7/forces_movement.shtml.

This site gives students a model race track and they can test different degrees of pushing and pulling while placing various obstacles on the track. The site is extremely student friendly.

"Pushes and Pulls." BrainPOP Jr. Accessed October 31, 2013. http://www.brainpopjr.com/science/forces/pushesandpulls/.
Featuring a short video on pushes and pulls, this site follows up with online interactive quizzes, writing activities, and cartoons.

Notes

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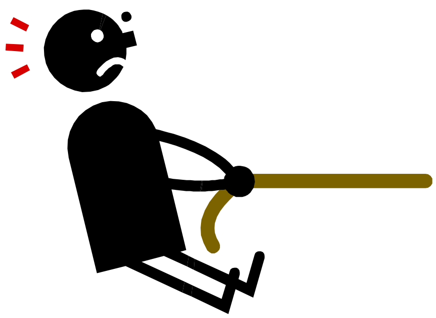
Appendix A: Force and Motion Vocabulary Flipbook

Force	
Position Words	
Push	
Pull	

Appendix B

Push/Pull Pictures to Sort (All pulled from Microsoft word clip art)



Appendix C

Implementing Common Core Standards

Common Core curriculum standards addressed in this unit are organized by content area and explained.

Mathematics:

CCSS.Math.Content.1.MD.A.2 Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps.

CCSS.Math.Content.1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

This standard will be addressed as students collect travel distances for each car design by measuring using pre-cut 12 inch squares, organizing measurements into a data table, and then graphing the results.

Language Arts/ Literacy

CCSS.ELA-Literacy.W.1.7 Participate in shared research and writing projects (e.g., explore a number of “how-to” books on a given topic and use them to write a sequence of instructions).

CCSS.ELA-Literacy.W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

These literacy standards are integrated into the curriculum unit through the use of student S.T.E.M. Fair journals. Students will be documenting observations and explaining the scientific process using their own grade level appropriate language.

Science

1.P.1.1 Explain the importance of a push or pull to changing the motion of an object.

1.P.1.2 Explain how some forces (pushes and pulls) can be used to make things move without touching them, such as magnets.

1.P.1.3 Predict the effect of a given force on the motion of an object, including balanced forces.

In the unit's introductory activities, students will gain an understanding of force and motion vocabulary and basic movement concepts. These terms will become mastered as students apply to them to the cars created and tested. This includes students' ability to explain, using simple terminology, why each of the cars moves forward.