Science Instructional Unit Plan: Motion and Forces

TLT 426: Science in Elementary Education

Dr. Bodzin

October 27, 2011

Gina Laura Ciani

Lehigh University

**Forces and Motion**

*This unit focuses on a basic understanding of motion including distance and speed and different forces that can affect motion such as gravity and friction.*

**Grade Level of Target Learners**

Grade 3

**Unit Learning Goals**

By the end of this unit, the third grader should be able to:

1. identify motion and forces affecting motion in the world around him or her.
2. recognize that all forces have an equal opposite force.
3. understand and identify the forces of gravity and friction.

**Standards Addressed by the Unit**

Pennsylvania Content Standards

* **3.2.B Physical Science: Physics:**
  + 3.2.3.B1. Explain how movement can be described in many ways.
  + 3.2.4.B1. Explain how an object’s change in motion can be observed and measured.
  + 3.2.6.B1. Explain how changes in motion require a force.
  + 3.2.3.A6. Science as Inquiry: Use data/evidence to construct explanations and understand that scientists develop explanations based on their evidence and compare them with their current scientific knowledge
* **PA ELPS Level 2 (Beginning)** 
  + Reading: Locate and classify information associated with natural resources, technologies or tools within a small group. *(applied as reading locating and classifying information associated with forces and motion within a small group or classroom group)*
  + Speaking: Describe the parts of the body presented in a model or illustration working with a partner. *(applied as describing motion and forces using models and illustrations in a small group or with a partner)*
* **PA ELPS Level 3 (Expanding)** 
  + Listening: Compare movement of real-life objects by following multiple step directions.
  + Writing: Describe and record objects made of different materials or textures from pictures or reality (such as: “The silk is shiny and smooth”). *(applied as using numbers and phrases to describe changes in motion and/or force)*

**Unit Learning Objectives**

1. The student will be able to use the terms motion, position, speed and distance to describe a race when prompted to use these vocabulary words with 100% accuracy.
2. Given an image with at least 20 forces that can be identified, the student will be able to identify at least 10 forces.
3. The student will be able to use the terms force, push and pull to describe what happens when a heavy box is moved when prompted to use these vocabulary words with 100% accuracy.
4. The student will be able to describe the force that makes objects fall and the force that makes objects stop moving using the terms gravity and friction, respectively, with 100% accuracy.
5. The student will be able to observe and collect data about motions as demonstrated by recording the time it takes a toy car to travel down a ramp at 3 different slopes. The student will be able describe which slope resulted in the fastest and slowest speed based on their recorded data with 100% accuracy.
6. The student will be able to describe changes in speed due to friction when given a model of different road textures on a toy car ramp is used. The student will complete this task with 100% accuracy.

**Assessment Plan**

I plan to use mostly formative active learning assessments, but an end of unit summative assessment as well. We will always begin by reading the chapter, but reviewing each page after it is read by the students. This will entail the teacher asking questions that highlight the key vocabulary from the page and having students answer the questions. For instance, after reading about speed, the teacher will ask what two things are needed to know something’s speed and prompt the children to reply “distance” and “time.” This will be an informal formative assessment. If children do not understand the key concepts on the page, the teacher will initiate a kinesthetic approach and have children model the new information in front of the class. This assessment will be appropriate for diverse learners because it is both visual (text and/or kinesthetic modeling) and verbal (question and discussion).

After each lesson in the text, an activity will be used to solidify the learning and act as a more formal formative assessment. Following the lesson on motion, the students will participate in an experiment tracking how different ramp heights (and slopes) affect the speed of the car. During discussion of this experiment, the students will be encouraged to use the terms: position, motion, distance and speed. Data will be discussed and inquiry based learning will bring the students to conclude that gravity pulled the car down and made the higher ramps have quicker speeds.

Following the lesson on forces, students will play a “game” where a picture of a playground scene is projected for the class. The students will have 10 minutes to write down as many forces in the image as they can. As a class we will review all the forces and write them on the board. Students should find at least 10 forces in the image (which will have at least 20 identifiable forces in it). The class will be motivated by being rewarded with an outdoor lesson review if it can find at least 15 as a class. They will have their lesson review outside either way, but this should be a great motivator.

After the lesson on friction, the students will participate in an experiment with the same car ramps but two different road materials (one control and one variable). The students will record data on which car made it down the ramp the fastest. This will establish a deep routed learning of friction.

As a review of the material, students will be formatively assessed one last time in the outdoor (or gymnasium) activity. We will have a student race and the students will subsequently identify position, motion, speed and distance. We will also have a heavy box push station and student will describe the forces involved (friction, gravity, push and pull).

The final, summative assessment will include a mix of the textbook-provided summative assessment (using a word box of vocabulary to fill in blanks about each science term) and images where students will describe the science. The images will be of the student race, box pushing and car experiments and students will be asked to describe the motion and forces using specified terms. All questions on the summative assessment will be read out loud to the students and students will be asked to not go ahead on the test. This will accommodate ELL students and students with special needs. Any assistive technology normally used by students will be allowed at all times during the science unit (instruction and assessment). If a diverse learner requires extra time on the test, this time will be given at the end of the test. Additionally, the word bank will assist ELL students with the assessment.

**Content Scope-and-Sequence**

Students will begin by learning what motion is (a change in position) and how we measure motion. Students will understand that motion is most often measured with speed and learn that both time and distance (the space between two positions) are required to find something or someone’s speed. Students will not need to go into further detail such as velocity, as only a basic understanding of motion and speed is required from Grade 3 and needed for the progression of the unit. From here, the class will segue into forces by realizing that speeds change and that gravity pulls items down. Students will learn that forces are always working in two directions and understand that when you push on a box it is also pushing on you and when you pull on a rope it is pulling on you as well. From here, students will be left with the question of what is pulling on something that is moving like a car or racing person. This will transition into friction. Students will need to fully understand forces and motion to grasp the concept of friction, so no movement to the topic of friction will be made until students are able to identify motion and forces on their own. Once friction is reached, the topic will need to be taught in several manners (reading, pictures, demonstrations and hands on) as it is hard to understand forces that are more difficult to see. Once friction is understood, students will review all the topics to understand the big picture. This full learning set in regards to motion and forces will prepare students for their next unit, simple machines.

**Instructional Strategies/Learning Experiences**

This unit will focus on a multiple learning model of teaching where students begin by reading a text on the material (beneficial for visual learners), move on to discuss the lesson as a class with a bit of lecture (beneficial for auditory learners), continue by using images and modeling where appropriate (beneficial for those with language deficiencies) and finish with a hands-on active learning experience (helpful to all learners by relating the science to an experience and their lives). The unit will be implemented with 6 lessons (1.5 motion, 1.5 forces, 2 friction, 1 review) and a summative assessment to be given at the end of the unit.

Day 1 (Introduction to Motion): Students will read Unit E, Lesson 1 of the McGraw-Hill Grade 3 Science textbook (except for the last two pages on maps) and complete the associated handout provided by the text book. Students will read either one page or one paragraph out loud to the class (one page if no vocabulary words are present (bold text) or one paragraph if one or more is present). After each page or paragraph, the teacher will ask students about what they read and touch on core topics within the lesson. A script of important questions to ask after each page or paragraph will be provided in the lesson plan. A word wall will be used for each bolded vocabulary word in the text. When a vocabulary word is encountered volunteers from the class will be used to model the meaning of the word and a student will suggest and image to draw next to the word wall word to remind students of the meaning. This is especially helpful for ELL because they may not be able to read the word, but will be able to identify the sight of the word with the sight of the picture.

After reading and discussing the text, the class will complete side one of the text-provided Lesson 1 Outline handout. The teacher will read each item out loud and have students volunteer possible “best answers” for the handout. The teacher will positively encourage students until the correct answer is provided and all students will write this word on their sheets. The teacher should write each answer on the board beside the question number to provide students with special needs and ELL students with the required time to write each answer and interpret the information. The same process will be used to complete the handout. Students will be told the keep this handout and use it to study for their unit test. The teacher must travel around the classroom while guiding students on the handout in order to make sure all students are writing the appropriate answers, so that this can be used as a study material.

Day 2 (What’s the Car Motion): Students will first review the prior day’s lesson and note key vocabulary words (position, motion, speed, distance). From here the class will help design an experiment where a toy car travels down a ramp of three different heights (slopes). The students will be prompted to suggest 3 trials at each height. From here, students will split into groups of 4-5 students with the students playing the roles of (1) ramp set up manager, (2) car releaser, (3) timer, (4) data recorder, and (5) lead scientist or group manager (optional). The students will release the car from the top of the ramp and allow it to move 1 foot from the base of the ramp and record the time the car took to move that distance. Students may be provided with a handout to aid in data recording. Students will proceed to complete this task with 3 trials at each ramp height and finally record their data on the board. The teacher will have the class get back together and average the data from the classes. Students will notice that it took the longest for the lowest ramp and that means that it’s speed was the lowest. The teacher should prompt students to explain why the higher ramps made the cars go faster and the lower ramps made the cars go slower. Eventually, a student will mention gravity and the teacher can use this to segue into the next lesson.

In classroom with ELL or students with special needs, this experiment can be made extremely inclusive. Students can be given jobs in their group appropriate to their ability levels or jobs that encourage growth. For instance, an ELL student might take on the role of the time (numbers are universal). Here, the student will be able to actively participate in the project and will be encouraged to use English to communicate with the other students in the group. He or she will need to tell the data recorded what the timer says and will have multiple oppurtunities to use his or her new language. Similarly, students with disabilities can easily be incorporated into this activity. A student with visual deficits might be the car releaser (a very tactile and auditory job) or a student with hearing loss might be in charge of positioning the ramp (a job that does not require audition). Clearly, this is a very inclusive activity for a variety of diverse learners.

Day 3 (Introduction to Forces, Force Finder): Day 3 will be very similar to Day 1, but will have students read the Lesson 2 unit of the same text. This unit describes forces and students will model gravity, force, push and pull. During the reading, students will be asked to push their desk into the floor to observe the push and push back; students will also have a quick tug-of-war in the hallway to model the pull and pull back forces. Similar to Day 1, a word wall should be used and child-suggested images drawn. It is best to build on the previous day’s word wall to allow students to similarly scaffold their learning. Again, students will read the test and discuss the text as a class in the same manner as Day 1. After reading, students will complete the Lesson 2 Outline handout provided by the text as a group and use this as a study resource.

At the end of the lesson, student will play a game. The teacher will tell the students that if they win, they will be able to do their unit review outside or in the gymnasium (based on weather). Students will look at a picture of a playground scene with a minimum of 20 identifiable forces in the image. This image will be projected to the class. Students will have 10 minutes to write down as many forces in the picture as they can. The class will come together and the students as a group should have 15 suggestions of forces for the teacher to write on the board in order to win the enriched review session. Students should always win this scenario, and the teacher may prompt answers if needed. Ideally, the class should be able to see more than 15 forces in the image and the teacher will know that students understand the force concept.

Day 4 (Introduction to Friction): Day 4 is again similar to Days 1 and 3. Students will begin by reviewing the previous lessons. The teacher should write on the board, “What makes things stop moving?” Before reading of the text begins, the teacher should engage students about what they think causes moving objects to stop. Kids will likely give answers based on the previous readings such as forces or gravity and the teacher should encourage this kind of thinking. After about 5 minutes, the teacher should say that the students will read to find out and Lesson 3 will be read from the McGraw-Hill textbook. Students will be excited to see pictures of the tug-of-war that the participated in the previous day in the text and background knowledge may be used throughout the chapter to understand the text. Again, a small amount of text should be read and discussed (and questions from each lesson plan must be used) and a word wall with images should be used. Modeling should be used wherever it is appropriate. The quick lab on page E28 (push a block of wood across the desk and then push the block of wood placed on top of a jar lid over marbles) may be passed around the classroom during the reading to provide a kinesthetic example of friction being reduced. Finally, the Lesson 3 Outline handout provided by the text should be completed as a class in the same manner as Day 1 and 3. This handout will again be used to study for the unit test (summative). At the end of the lesson, student should be prepared for a transition into the Day 4 Lesson and experiment. Ask students how they think friction affected their car ramp activity from Day 2. Find out what the students think might change their results. Prompt students to think about how friction might be altered. This will get students excited for the Day 5 experiment.

Day 5 (Fun with Friction): Today students will use inquiry-based learning to solidify their understanding of friction. Student will use the same ramps as used during the Day 2 activity on the highest high setting. One ramp will be called the control ramp and the other the variable ramp. Students will have sandpaper, wax paper, corrugated cardboard and tinfoil to place on the ramp. The students should hypothesize whether each surface will result in a faster or slower motion as compared to the control. Students will break into their groups from Day 2 and proceed with jobs similar to that of Day 2. During this lesson there will be (1) a ramp maintenance technician (makes sure ramps are both set up correctly), (2) a dual car releaser, (3) a surface manager, (4) a data recorder and (5) lead scientist (optional). The teacher may choose to either rotate the positions within the groups or to maintain the positions. Keeping the same roles is suggested for classrooms with ELL or students with special needs in order to fairly maintain appropriate roles for each student’s needs. As the timer is not used in this activity, the ELL student may be more appropriately placed as the car releaser (little language required). With the new tactile element, a blind student might be best suited to be the surface manager. Teachers can use discretion to appropriately place each student in the least restrictive, best-fit role.

Once groups are in place, the experiment must be conducted. Each surface should be tried at least 3 times and compared to the control. Students will then use the mode (answer that appeared most frequently) to give a descriptive statistic for each condition. After completion of the experiment, the classes attention should be on the teacher and the students will raise their hands in the style of voting to tell which conditions were faster. The data will be recorded on the board and students will draw conclusions about friction based on the data.

Day 6 (Review Run Through): This lesson is a review of the forces and motion unit in a fun, centers format. Students should participate in this lesson either outdoors or in a gymnasium. To begin, students will review their handouts from Days 1, 3 and 4. After the review students will head to the activity center (outside or gym) for centers.

The first center will be a race. Students will participate in a race. The teacher will ask students to first show position A (starting position) and then show what they thing position B will look like (ending position). Next the students will describe the distance by explaining that it is the space between positions A and B. Finally students will have their race and discuss who had the fastest/slowest speed and why. Students should talk about the time it took to travel the full distance to describe the speeds.

The next center will be a pushing station. Students will first try to push over the school or the gym wall. They should describe what they feel. Next boxes full of text books should be on the floor and children challenged to push them. Again, student should describe what they feel and pay special attention to the forces involved. Have students talk about how they pushed on the box, the box pushed on them, their sneakers pushed on the floor and the floor pushed them back.

The next center will be the gravity or flying station. Students should be challenged to try to fly or jump the highest at this station. Students should not be able to fly. Ask the students why they are stuck to the ground and have them talk about gravity.

The next center will be a tug-of-war or pulling station. Have students re-create their activity from Day 2 and discuss the pulling forces and pushing forces involved. Ask the students to describe any changes in motions they observe.

The last center is friction. If outdoors, have students try to walk without lifting their feet, with leaping or normally. What is different? Have a scooter board available and let children take turns pushing each other on this board. What happens to the friction? If indoors, the same procedures can be used with the addition of a sock slip and slide. Allow children to run in socks and slide across the floor. Ask them what is going on and prompt answers about friction.

Day 7 (Summative Assessment): This is the unit test. There is no lesson plan for this day; however, adaptations for diverse learners may be needed. A unit test with images in place or in addition to words might be necessary. Similarly, some students might need more time or adaptive technology during the test. Finally, the test should be read aloud to the children and students should be asked not to go ahead. Each item may be read slowly and clearly two times so that all students have different processing of the text available to them.

**Instructional Materials and Resources**

I plan to begin by using the Lesson Outline Handouts provided by the McGraw-Hill textbook. This company has been in business a long time and has proven to have very reliable materials as is seen by their reliability throughout the country. Most items are fill-in-the-blank items but on assessments, a word bank is available. This helps students with special needs and language learners. With the addition of reading each item aloud, these assessments seem optimal.

In addition to the handouts, I will use the McGraw-Hill textbook to initiate learning. This textbook has many colors and images in addition to the text which give diverse learners and equal opportunity to understand the material. The book provides questions for gifted and talented students to extend their learning and the teaching manual makes sure instructors have the information they need to effectively discuss the material presented.

For formative assessments, I will constantly use classroom question and answer techniques. I understand that this is not optimal for students with hearing loss or ELL students, but features such as the image-linked word wall and modeling will help make this information accessible and help me to informally assess these specific learners. For instance, a student with very little spoken English abilities might be able to model a concept cued from the word wall. Moreover, modeling has much research backing its effectiveness when appropriately implemented in the classroom setting.

In addition to questioning and answers, I have incorporated many hands-on activities to allow students to develop content knowledge related to the subject matter. Students will be able to use inquiry-based learning in both the differing ramp height and ramp surface material experiments. Inquiry-based learning has an extensive research base backing its effectiveness. Additionally, students with little prior background knowledge of these phenomena will develop some knowledge about the topics they can use for reference.

The review segment of this unit is both self-developed and based on research and suggestion. Kinesthetic learning has much empirical support and the review seems like it work as a proper assessment for students that might not perform well on a written exam. Perhaps having an interview-type assessment for diverse learners with weak writing skills might be most appropriate and deal with references to the review activities. Each element of the review activity is based on activities suggested by the text and are all kinesthetic and exploratory in nature. This review allows multi-sensory reinforcement of the concepts of the science unit and allows a child with sensory impairments to experience each element of the lesson with his or her remaining senses. Moreover, this multi-faceted approach to learning has been shown to result in better learning recall.

Finally, the test is an element that I continue to work on. I want to incorporate both elements of the unit test from the text book as well as elements using photographs from the review activities and students’ descriptions of each using cited vocabulary words. This will be exclusive for ELL students, but the interview approach or perhaps simply labeling items with the vocabulary words in the images will be appropriate. As the lesson plans are developed, I will work on locating more assessment techniques to use with diverse learners that will allow for an appropriate and inclusive assessment.