Forces and Motion Are Affected by Objects around Them

By Joann Ormonde

CCSS: KPS2-1 Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

KPS2-2 Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

Science and Engineering Practices: In this lesson, the students will plan and carry out investigations to answer questions or test solutions to problems. K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions with guidance.

Crosscutting Concepts: Apply scientific inquiry to complete simple tests designed to gather evidence to support or refute student ideas and causes.

Summary

In this lesson, the students will explore the science of forces, motion, and the effect of friction on objects in motion. Students will be looking specifically at the cause and effect of surfaces and angles as variables, and how one object can affect and/or change the direction of another object. They will chart, explore, predict, record, justify, and revise outcomes to help make sense of the world around them. The teacher will provide experiences and questions that will set the lesson’s path towards rigor, relevance and engagement. (Teacher poses Quad A, B, C, and D, questions. Explanation is found in the Instructional Moves section) Complete lesson plan is found in the Instructional Task Description.

Overview of the Formative Assessment Process in This Resource

Clarifying Intended Learning

Learning Goal:

- Students will be able to demonstrate how to impart a force on one object that can transfer force to another object and change the second object’s direction and speed (i.e. billiards balls, tennis balls, ramps, cars, and items blocking ramp traffic).
• They will also be able to explain the effect of friction on an object in motion (i.e. ramps with landing variables).

**Success Criteria:**
• Student prediction accuracy will increase as they go through the acquisition of knowledge through, viewing a video, reading a book whole group, hands on experimentation, such as building a ramp, and later modifying it and analyzing the information.
• Students will justify the outcomes of their modified ramps by writing an independent paper on the results of their experiment.
• Students will use knowledge of force, motion, and friction to construct a ramp that will allow their car to travel the farthest they believe it can.
• Students will support their method and outcome by measuring and sharing out to the class.

**Elicit Evidence:**

**Engage:**

**Phenomenon - Video of Pool Trick Shots – Kid Magic**
Students list their observations, stopping to revisit events in the video.
Complete the list.
What do you think caused what was happening? C, Go to cause and record students’ explanation of causes.
Teacher records student responses on class chart
What are some of your questions after watching this video? B (separate chart)
Teacher records student responses on class chart.

**Explore:**

Picture Walk *Science in Motion* by Nancy White and Marilyn Locker
Teacher poses Quad A, B, C, questions for students to answer, in response to the pictures they see. Teacher then reads the book and students reflect as they listen along. The students then follow with series of experiments on floor with various tools (tennis balls, billiard balls). They then make predictions about items in the classroom that the students use every day.

**Explain:**

Students explore the ‘Ramp’ experiment to see if items can change the direction or stop a car. Students predict, and record the outcome. Draw the first ramp, and label.
Teacher poses Quad A, B, C, and D, questions. Students respond and draw their own conclusions.

**Elaborate:**

Teacher will facilitate by introducing a video, “What is Friction? - Physics for Kids” and how it affects motion. Teacher poses Quad A, B, C, and D, questions. (Explanation is found in Instructional Moves) Students respond and draw their own conclusions. Then
students go back to the last ramp set up, and modify it in a way that they think will make the car go faster, taking into consideration that friction can have a determining effect on the results. They predict, record, and then write about their findings, and what were the determining factors where that led to those results. Conclusions are drawn by students, and written by students independently.

Interpret Evidence

All participating students were completely engaged, excited, and willing to share input with each other and the facilitating teacher. All students did the final writing activity where they stated their own conclusions regarding friction, including all of my ELL and SST students.

Students were able to go back to their original questions, speak to them and respond to any preconceived notions about their observations, with new insight and clarity.

Act on Evidence

When phenomenon was presented in whole group, the students brainstormed observations, suggested causes, and asked questions while the teacher recorded on a chart. Think-pair-share, discussions, and hands-on experiences were integral parts of the lesson.

My English Language Learners (ELL) and Student Success Team (SST) students participated in all activities and gave input in both whole group and small group situations. All students in the class experienced the verbal, and hands-on activities, while interacting with their peers and/or the facilitating teacher.

During small group time my ELL and SST students actively engaged in the activities with smiles and enthusiasm. These students openly expressed their thoughts about the outcomes and their causes.

Then, all students participated in predicting and recording outcomes, stating why those outcomes occurred, recording a line of learning about the ramp before and after modifying it, and finally writing an informative piece on what happened and why they thought it might have had that particular outcome.

Last, the class teams competed to design the ramp that would take their car the furthest by using their knowledge of forces and motion, keeping in mind the effect of friction on their end results.

Feedback

- Use questions to guide students from Quadrant A to quadrant D thinking. (Refer to the Instructional Moves link in the Table of Contents for a description of Quadrants A, B, C, and D.)
- Note whether their predictions are improving with their experience.
• When the students are doing the writing portion of the lesson, require them to justify the outcome.
• Have the groups share out their outcomes and justify those outcomes during the contest portion of the lesson.
• Have the students who gave input in the beginning of the lesson review their original statements and revise if needed. Others may contribute and add newly acquired information to the charts as well.

Instructional Moves:
All students participate in offering input by making every student accountable during their small group experimentation. Teacher solicits responses by rotating through the group. Each student should have the opportunity to take a leadership role, by doing the hands-on steps, while those that are observing give input about the outcomes.

To enhance the rigor and relevance of the lesson the teacher should ask questions that progress from Quad A to Quad D. The Rigorous Learning Toolkit, copyright 2015 by Center for Leadership in Education, contains Teacher Question Stems by Quadrant, on page 16, which is a quick reference showing questions that increase rigor in all of your lessons. You will see, in this lesson, that I have labeled the level of the questions the teacher asks the students, A, B, C, or D. This allows the teacher to guide the students into high level thinking.

Quad A questions…recall, make observations, demonstrate understanding
Quad B questions…apply or relate
Quad C questions…summarize, analyze, organize, evaluate
Quad D questions…predict, design, or create

Using structures that require all students to participate allows all students to grow both socially and academically. e.g. Ask the students to discuss findings assigning them each of them a number in think-pair-share. Ask student number 1 to tell student number 2 what they think. Then ask student number 2 to share what student number 1 said. Now have students reverse rolls while responding to a question posed by the teacher. This encourages active listening and full participation from all students.

Instructional Task Description

Lesson Plan: Forces and Motion are Affected by Objects Around Them

Engage:
Phenomenon - Video of Pool Trick Shots – Kid Magic
https://www.youtube.com/watch?v=ByuSI81ditY&t=22s
Teacher: What did you observe? A (Refer to the Instructional Moves link, in the Table of Contents, for a description of Quadrants A, B, C, and D questioning.)

Chart #1 List the observations with stopping to revisit events in the video. Complete the list on a chart: what they observe on the left side of a center line and what they think is the cause on the right side of the center line.

What do you think caused what was happening? C Chart #1 Go to cause and record students’ explanation of causes.

Teacher records student responses on class chart #1

What are some of your questions after watching this video? B Chart #2 (separate chart)

Teacher records student responses on class chart #2

Students: Include think-pair-share in this process to include all students.

Explore:
Picture Walk Science in Motion by Nancy White and Marilyn Locker

Teacher: How do you think skiers move? (Pg. 3 of text) Quad B

How would you move a wagon? (Pg. 4) B

The ball is moving toward the girl. How will she change its direction? (Pg. 8) C WHY? C

What would happen if the force came from a different direction? (Pg. 9) C

What is happening to the panda? Why? (Pg. 11) A

Are they pushing or pulling? How can you tell? (Pg. 14-15) B

Students: Answer questions posed to group

Now read book

Students will demonstrate knowledge of pushes and pulls by demonstrating pushes and pulls on various objects in the classroom

Explore:
Sit students in a circle in the classroom.

Let’s see what happens when we roll balls in the classroom.


Students experience both types of ball, weight, texture.

Students explain what they think is happening and why with the knowledge they have acquired so far in the lesson (Learn about the connection of cause and effect.)
**Explain:**
Let’s explore with some things in the classroom and take out some toys to discover what might happen.

**Teacher** will ask questions.

How can you demonstrate pushes/pulls on the box/book cart/chair, etc.? A

Harder or easier on floor / rug? A

Why? C

**Students** will demonstrate knowledge of pushes and pulls by demonstrating pushes and pulls on various objects in the classroom (Apply what you have earned)

**Explore:**
Teacher will set up ramp and provide hot wheels for students test rolling down the ramp.

**Items to be tested at the end of the ramp…**

The objects are passed around to each student in small groups before placing them at the end of the ramp. (Students can determine size and weight) (Folded paper, cotton balls, sponge, marker, linker cube train)

**Students** will explore forces and motions by rolling hot wheels down a ramp with various items at the end of the ramp, predicting what will happen, record, and verifying the results.

Based on their prior knowledge, students will predict results on their own personal chart, record results to confirm the predictions or to acknowledge alternative results, and share why their predictions were confirmed or dis-proven.

**Explain:**
Teacher poses questions to help students investigate and draw conclusions, such as:

What objects were able to stop the cars? A

Why do you think they were able to stop the cars? C

Can we make a conclusion about what type of object was needed to stop the cars? C

Can you think of some other thing that we could put at the end of the ramp that might stop the cars, and tell me why? D

**Students** respond to the teacher’s questions, explore the added possibilities, and draw their own conclusions from the testing.

**Elaborate:**
https://www.youtube.com/watch?v=qux5wMu9mqI
Teacher: How can you modify the ramp? D
What do you predict will happen? D
What if I change the surface at the bottom of the ramp? D
What do you predict will happen? D
(First ramp had 2 books stacked, landing in the folded paper, 2nd ramp will have ______ books stacked and land on a blanket, carpet, or floor.)

Students will modify the ramp and predict what will result due to the modifications.

Evaluate:
Teacher will observe the student modification of their ramps, and verify that the student’s predictions and results support each other. D

Students will record what happened when they modified the ramp by drawing a picture, and state yes or no in reference to their prediction.

Students can also follow up with informative writing about what happened and why. They can write about their modified ramp and how it was affected by friction.

As a final activity, the 4 teams of students will compete by designing a ramp with the tools and supplies allotted by the teacher. The goal of each group is to design the ramp that will allow their car to travel the farthest. The students will use their newly acquired knowledge about force, motion, and friction, to design the ramp that they believe will enhance the distance that their car travels. D

Students work in teams with materials provided by the teacher to see which group can create the ramp that sends their car the farthest. The students will compete to see which group can structure a ramp, while considering the surfaces and ramp design which will allow their team’s car to travel the farthest. Results will be measured.

Outcomes are discussed, and the students share their ideas as to why.

Students share out the final result by measuring how far each of their cars travels down their ramp. They compare those results with other groups and discuss why they may have had those outcomes.

Teacher will revisit original charts, the class will make adjustments as a whole group, and the class will celebrate their accomplishments!

Additional Comments and Considerations from the Author(s)

Working with 5 and 6-year-olds can be both rewarding and challenging. The level of questioning can greatly determine the outcome of student learning. The teacher can
enhance their students' higher level thinking ability when he or she increases the rigor, relevance, and engagement of the lesson. Looking at the Description of Hess’ Cognitive Rigor Matrix (Consortium on Reaching Excellence in Education), one can see examples of questions that reflect different levels of DOK (Depth of Knowledge). They are separated into four quadrants using a variety of levels that deepen the experience of increased rigor, relevance, and engagement. The Rigorous Learning Tool Kit, (Copyright 2015) by the International Center for Leadership in Education, simplifies these four quadrants by labeling the A<B<C< or< D, increasing in complexity from A to D. This document is an effective tool when developing questions that direct student learning.

During this lesson, I have labeled teacher questions accordingly and student participation as well.

**Student Materials and Additional Resources Links**

**Suggested Materials:**
- Book: *Science in Motion* by Nancy White and Marilyn Locker
- Video projector
- Chart paper
- Ramp materials
- Miniature cars such as “Hot Wheels”

**Suggested Rolling Objects:**
- Tennis balls
- Billiard balls

**Suggested Obstacles:**
- Folded 8½ by 11 papers
- Cotton balls
- Sponges
- Markers
- Linker cubes
- Student pencils
- Recording sheet & line of learning (see below)

**Suggested Landing Surfaces:**
- Carpet
- Blanket material (felt or flannel)
- Tile flooring

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