Kindergarten – Motion and Stability: Forces and Interactions (Pushes and Pulls)

Question 1: What performance expectations are related and can be included in instruction within the lessons/unit? (Cluster PEs)

K-PS2-1. 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.
K-PS2-2. 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.*

Question 2: What are the performance expectations, clarification statements, and assessment boundaries and how are they related in terms of instructional practices?

K-PS2-1. 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.
Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.

Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.

Comments/Thoughts: Given the experiences and understandings that students have acquired about motion, they should be given a set of experiences that confront or challenge their thinking.

K-PS2-2. 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.*
Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.

Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.

Comments/Thoughts: Another possible problem could be to change direction/speed to travel to a specific destination.

Question 3: What are the disciplinary core idea(s), practices, and crosscutting concepts coded to the performance expectations and how will they drive instruction?

Disciplinary Core Ideas:
- PS2.A: Forces and Motion
  - Pushes and pulls can have different strengths and directions.
  - Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.
- PS2.B: Types of Interactions
  - When objects touch or collide, they push on one another and can change motion.
- PS3.C: Relationship between Energy and Forces
  - A bigger push or pull makes things go faster.
- ETS1.A: Defining Engineering Problems.
  - A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.

Science and Engineering Practices:
- Asking questions and defining problems
- Planning and carrying out investigations*
- Analyzing and Interpreting data*
- Constructing explanations and designing solutions

Cross-Cutting Concepts:
- Cause and Effect
  Simple tests can be designed to gather evidence to support or refute students' different ideas about causes.

Question 4: What understandings need to be developed for students to be successful in the performance expectation(s)? What content ideas will they need to know and what skills will they need to learn?
Kindergarteners will need to understand:
- a push and/or a pull as a force that affects motion.
- that an object moves in the direction of the push or pull.
- that pushes and pulls can speed up, slow down, or change the direction of an object.
- that size, weight, and shape of an object affects its motion.

Kindergarteners will need to be able to:
- describe motion in terms of objects around it.
- make observations of motion and generate questions about motion
- plan and conduct simple investigations into motion
- construct simple charts from motion data and observations.
- share ideas about motion and communicate findings orally and through drawings and writings.
- recognize patterns in the affect of pushes and pulls on objects.
- gather information from books and one another
- demonstrate concepts of motion through illustrations and performances
- analyze a design in terms of its ability to change direction or speed of a moving object.

Question 5: What Science and Engineering Practices are appropriate with the instruction of the disciplinary core ideas? (See Appendix F for description of Practices for K-2)

Practice 1: Asking questions (for science) and defining problems (for engineering) – Students will make observations of objects in motion and ask questions regarding the force that started the object in motion, changes in direction, and changes in speed of the object. They will also consider a problem in designing a solution to changing the speed or direction of a moving object.

Practice 3: Planning and carrying out investigations – Students will plan and carry out investigations from their own questions regarding the motion of an object.

Practice 4: Analyzing and interpreting data – Students can collect data regarding the motion of an object and describe patterns in the amount of force and the speed of an object, the amount of force and the weight of an object, and the amount of force to change the direction or speed of an object. Students can compare predictions and data from observations and compare data between similar investigations by peers.

Practice 5: Using mathematics and computational thinking - Students may, depending on time of year, be able to compare measurements of distance traveled of different objects with different forces. (not explicit at this level)

Practice 6: Constructing explanation (for science) and designing solutions (for engineering)- Students construct explanations based on data and observations of moving objects. Students may use tools to design a device that changes the direction or speed of a moving object.

Practice 8: Obtaining, evaluating, and communicating information – students can analyze informational text and communicate information as well as communicate information gained from observations, data, and investigations.

Question 6: What are the lesson level expectations (learning performances) and how will they build to meet the performance expectations?

- Share ideas about motion and communicate prior understanding.
- Make observations of motion and communicate findings based on observations.
- Plan and conduct simple investigations into motion.
- Demonstrate pushes and pulls as necessary forces to start an object in motion.
- Relate informational text regarding motion with motion investigations and observations in the classroom.
- Make purposeful observations of a variety of objects in motion and identify patterns in motion of variety of objects.
- Design a device that will change the motion or speed of an object.

Question 7: What assessment (formative and summative) will provide evidence of the understanding and/or ability to perform lesson level expectations (learning performances)?

- Students draw and use approximation of writing to record observations and understandings.
- Student interviews and oral presentations of findings and understandings.
- Whole class discussion, written responses, and interviews regarding response to informational text and relation to classroom activities.
- Student demonstrations and written and oral explanations of investigations and findings.
- Student demonstrations and written and oral explanations of engineering designs to change the motion of an object.

Question 8: What is the storyline that helps learners apply what they know, build new, sophisticated ideas from observation and evidence, and use information to solve an engineering problem?

Students begin their study in motion with a discussion of what they already think and have experienced about motion. They confront their ideas through observations of a variety of objects in motion. Students are guided through the process of looking for patterns and constructing explanations for pushes and pull and how they are related to starting objects in motion, changing the direction of objects in motion, and changing the speed of objects in motion. After students have recognized patterns in motion they can make predictions about motion and test their predictions. Direct involvement with objects in motion, recognition of pushes and pulls as forces that affect objects in motion (causation), and recognition of patterns in how pushes and pulls affect motion, give students the ability to analyze a design to change the motion or speed of an object.

Question 9: How do the lessons and tasks help students move towards an understanding of the performance expectation(s)?

The sequence of lessons engages students directly with objects in motion and through text in the cause and effect of forces (pushes and pulls) and motion. Through experiences, investigations, analysis of observations and results, students gain sufficient knowledge and skill (practices) to be able to analyze an engineering device for its ability to change the speed or direction of an object in motion.