Kindergarten Thematic Model - Bundle 3
Pushes and Pulls

This is the third bundle of the Kindergarten Thematic Model. Each bundle has connections to the other bundles in the course, as shown in the Course Flowchart.

Bundle 3 Question: This bundle is assembled to address the question of "How do pushes and pulls affect the motion of an object?"

Summary

The bundle organizes performance expectations around the theme of *how pushes and pulls affect the motion of an object*. Instruction developed from this bundle should always maintain the three-dimensional nature of the standards, but recognize that instruction is not limited to the practices and concepts directly linked with any of the bundle performance expectations.

Connections between bundle DCIs

Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it (PS2.A as in K-PS2-1 and K-PS2-2). This concept of motion connects to the idea that a bigger push or pull makes things speed up or slow down more quickly (PS3.C as in K-PS2-1).

The concept of pushing or pulling on an object (PS2.A as in K-PS2-1 and K-PS2-2) also connects to the idea that, when objects touch or collide, they push on one another and can change motion. (PS2.B as in K-PS2-1)

The idea that a bigger push or pull makes things speed up or slow down more quickly (PS3.C as in K-PS2-1) connects to the concept that pushes and pulls can have different strengths and directions (PS2.A as in K-PS2-1 and K-PS2-2).

The concept that people measure weather conditions to describe and record the weather and to notice patterns over time (ESS2.D as in K-ESS2-1) connects to the idea that it is useful to compare and test designs (ETS1.C as in K-2-ETS1-3) through data analysis.

The ideas that a situation that people want to change or create can be approached as a problem to be solved through engineering (ETS1.A as in K-PS2-2) and that, because there is always more than one possible solution to a problem, it is useful to compare and test designs (ETS1.C as in K-2-ETS1-3) could connect to multiple physical science concepts in this bundle. For example, these concepts could connect to the idea that when objects touch or collide, they push on one another and can change motion (PS2.B as in K-PS2-1) through a task in which students are challenged to work in groups to change the direction or speed of a ball with another object and then test and compare each group's solution. Alternatively, these engineering concepts could connect to the idea that a bigger push or pull makes things speed up or slow down more quickly (PS3.C as in K-PS2-1) through a different task in which students are asked to pull or push an object in a certain amount of time and then challenged to do it faster. Students could then compare their solutions and reflect on how their pull or push needed to change in order to move the object faster.

Bundle Science and Engineering Practices

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the practices of planning and carrying out investigations (K-PS2-1); and analyzing and interpreting data (K-PS2-2, K-ESS2-1, and K-2-ETS1-3). Many other practice elements can be used in instruction.

Bundle Crosscutting Concepts Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the crosscutting concepts of Patterns (K-ESS2-1) and Cause and Effect (K-PS2-1 and K-PS2-2). Many other crosscutting concepts elements can be used in instruction. *All instruction should be three-dimensional.*	
Performance Expectations K-2-ETS1-1 and K-2-ETS1-3 are partially assessable	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.*]** 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.*]** K-ESS2-1. **Use and share observations of local weather conditions to describe patterns over time. [Clarification Statement: Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [*Assessment Boundary: Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.*]** K-2-ETS1-3. **Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**
Example Phenomena	Two balls of the same size collide and change direction. A cart pulled across a floor moves quicker with a strong pull than with a weak pull.
Additional Practices Building to the PEs	**Asking Questions and Defining Problems** ● Ask questions based on observations to find more information about the natural and/or designed world. Students could *ask questions based on observations to find more information about* ***the effects of different strengths or different directions of pushes and pulls on the motion of an object.*** K-PS2-1 and K-PS2-2 **Developing and Using Models** ● Develop and/or use a model to represent amounts, relationships, relative scales (faster/slower), and/or patterns in the natural and designed world(s). Students could *develop or use models to represent relationships and relative scales (e.g, faster and slower)* [of the] ***change [in] direction of an object***. K-PS2-2

Additional Practices Building to the PEs (Continued)	**Planning and Carrying Out Investigations** ● Make predictions based on prior experiences. Students could *make predictions* [about] ***patterns of local weather over time*** *based on prior experiences*. K-ESS2-1 **Analyzing and Interpreting Data** ● Use and share pictures, drawings, and/or writings of observations. Students could *use and share pictures, drawing, and/or writings of* [their] *observations* [of how] ***pushes and pulls can have different strengths and directions***. K-PS2-1 and K-PS2-2 **Using Mathematical and Computational Thinking** ● Decide when to use qualitative vs. quantitative data. Students could decide when to use qualitative vs. quantitative data ***to compare and test designs***. K-2-ETS1-3 ● Use counting and numbers to identify and describe patterns in the natural and designed world(s). Students could *use counting and numbers to identify and describe* ***patterns of local weather over time.*** K-ESS2-1 **Constructing Explanations and Designing Solutions** ● Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. Students could *make observations (firsthand or from media) to construct an evidence-based account for* [how] **pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.** K-PS2-1 and K-PS2-2 Students could *make observations to construct an evidence-based account for* ***patterns of local weather over time*** K-ESS2-1 **Engaging in Argument from Evidence** ● Listen actively to arguments to indicate agreement or disagreement based on evidence, and/or retell the main points of the argument. Students could *listen actively to arguments* [about how] **pulling on an object can change the direction of its motion** to *indicate agreement of disagreement based on evidence or retell the main points of the argument.* K-PS2-1 and K-PS2-2 **Obtaining, Evaluating, and Communicating Information** ● Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea. Students could *describe how specific images (e.g., a diagram weather) support* [the] *scientific idea* [that] ***people measure weather conditions to describe and record the weather and to notice patterns over time.*** K-ESS2-1

Additional Crosscutting Concepts Building to the PEs	**Patterns** ● Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. Students could *observe patterns* ***of motion*** *and use these patterns as evidence* ***of the effects of different strengths or different directions of pushes and pulls on the motion of an object***. K-PS2-1 **Scale, Proportion, and Quantity** ● Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower). Students could use *relative scales (faster and slower, higher and lower, longer and shorter) to compare and describe* ***the effects of different strengths or different directions of pushes and pulls on the motion of an objec*****t.** K-PS2-1 **Structure and Function** ● The shape and stability of structures of natural and designed objects are related to their function(s). Students could reflect on how *the shape and stability of structures of objects are related to* ***the effects pushes and pulls of different strengths or different directions [have] on the motion of*** [the] ***object***. K-PS2-1
Additional Connections to Nature of Science	**Scientific Investigations Use a Variety of Methods** ● Scientific investigations begin with a question. Students could *begin a scientific investigation with a question* [about how] ***pushing or pulling on an object can change the speed or direction of its motion and can start or stop it*** and then reflect on the fact that their investigation began with a question**.** K-PS2-1 and K-PS2-2 **Science is a Way of Knowing** ● Scientific knowledge informs us about the world. Students could describe how *scientific knowledge* [about how] ***pushing or pulling on an object can change the speed or direction of its motion and can start or stop it*** *informs us about the world*. K-PS2-1 and K-PS2-2

K-PS2-1 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

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.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 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, plan and conduct an investigation in collaboration with peers.

Connections to the Nature of Science

Scientific Investigations Use a Variety of Methods

- Scientists use different ways to study the world.

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 speed up or slow down more quickly. *(secondary)*

Crosscutting Concepts

Cause and Effect

- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Observable features of the student performance by the end of the grade:		
1	Identifying the phenomenon to be investigated	
	a	With guidance, students collaboratively identify the phenomenon under investigation, which includes the following idea: the effect caused by different strengths and directions of pushes and pulls on the motion of an object.
	b	With guidance, students collaboratively identify the purpose of the investigation, which includes gathering evidence to support or refute student ideas about causes of the phenomenon by comparing the effects of different strengths of pushes and pulls on the motion of an object.
2	Identifying the evidence to address this purpose of the investigation	
	a	With guidance, students collaboratively develop an investigation plan to investigate the relationship between the strength and direction of pushes and pulls and the motion of an object (i.e., qualitative measures or expressions of strength and direction; e.g., harder, softer, descriptions* of "which way").
	b	Students describe* how the observations they make connect to the purpose of the investigation, including how the observations of the effects on object motion allow causal relationships between pushes and pulls and object motion to be determined
	c	Students predict the effect of the push of pull on the motion of the object, based on prior experiences.
3	Planning the investigation	
	a	In the collaboratively developed investigation plan, students describe*:
		i. The object whose motion will be investigated.
		ii. What will be in contact with the object to cause the push or pull.
		iii. The relative strengths of the push or pull that will be applied to the object to start or stop its motion or change its speed.
		iv. The relative directions of the push or pull that will be applied to the object.

		v. How the motion of the object will be observed and recorded.
		vi. How the push or pull will be applied to vary strength or direction.
4	Collecting the data	
	a	According to the investigation plan they developed, and with guidance, students collaboratively make observations that would allow them to compare the effect on the motion of the object caused by changes in the strength or direction of the pushes and pulls and record their data.

K-PS2-2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

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.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Analyze data from tests of an object or tool to determine if it works as intended.

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.

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. *(secondary)*

Crosscutting Concepts

Cause and Effect

- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Observable features of the student performance by the end of the grade:		
1	Organizing data	
	a	With guidance, students organize given information using graphical or visual displays (e.g., pictures, pictographs, drawings, written observations, tables, charts). The given information students organize includes:
		i. The relative speed or direction of the object before a push or pull is applied (i.e., qualitative measures and expressions of speed and direction; e.g., faster, slower, descriptions* of "which way").
		ii. The relative speed or direction of the object after a push or pull is applied.
		iii. How the relative strength of a push or pull affects the speed or direction of an object (i.e., qualitative measures or expressions of strength; e.g., harder, softer).
2	Identifying relationships	
	a	Using their organization of the given information, students describe* relative changes in the speed or direction of the object caused by pushes or pulls from the design solution.
3	Interpreting data	
	a	Students describe* the goal of the design solution.
	b	Students describe* their ideas about how the push or pull from the design solution causes the change in the object's motion.
	c	Based on the relationships they observed in the data, students describe* whether the push or pull from the design solution causes the intended change in speed or direction of motion of the object.

K-ESS2-1 Earth's Systems

Students who demonstrate understanding can:

K-ESS2-1. **Use and share observations of local weather conditions to describe patterns over time.** [Clarification Statement: Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [*Assessment Boundary: Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.

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Connections to Nature of Science

Science Knowledge is Based on Empirical Evidence

- Scientists look for patterns and order when making observations about the world.

Disciplinary Core Ideas

ESS2.D: Weather and Climate

- Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.

Crosscutting Concepts

Patterns

- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Observable features of the student performance by the end of the grade:		
1	Organizing data	
	a	With guidance, students organize data from given observations (firsthand or from media) about local weather conditions using graphical displays (e.g., pictures, charts). The weather condition data include:
		i. The number of sunny, cloudy, rainy, windy, cool, or warm days.
		ii. The relative temperature at various times of the day (e.g., cooler in the morning, warmer during the day, cooler at night).
2	Identifying relationships	
	a	Students identify and describe* patterns in the organized data, including:
		i. The relative number of days of different types of weather conditions in a month.
		ii. The change in the relative temperature over the course of a day.
3	Interpreting data	
	a	Students describe* and share that:
		i. Certain months have more days of some kinds of weather than do other months (e.g., some months have more hot days, some have more rainy days).
		ii. The differences in relative temperature over the course of a day (e.g., between early morning and the afternoon, between one day and another) are directly related to the time of day.

K-2-ETS1-1 Engineering Design

Students who demonstrate understanding can:

K-2-ETS1-1. **Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.**

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions.

- Ask questions based on observations to find more information about the natural and/or designed world(s).
- Define a simple problem that can be solved through the development of a new or improved object or tool.

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- A situation that people want to change or create can be approached as a problem to be solved through engineering.
- Asking questions, making observations, and gathering information are helpful in thinking about problems.
- Before beginning to design a solution, it is important to clearly understand the problem.

Crosscutting Concepts

Observable features of the student performance by the end of the grade:		
1	Addressing phenomena of the natural or designed world	
	a	Students ask questions and make observations to gather information about a situation that people want to change. Students' questions, observations, and information gathering are focused on:
		i. A given situation that people wish to change.
		ii. Why people want the situation to change.
		iii. The desired outcome of changing the situation.
2	Identifying the scientific nature of the question	
	a	Students' questions are based on observations and information gathered about scientific phenomena that are important to the situation.
3	Identifying the problem to be solved	
	a	Students use the information they have gathered, including the answers to their questions, observations they have made, and scientific information, to describe* the situation people want to change in terms of a simple problem that can be solved with the development of a new or improved object or tool.
4	Defining the features of the solution	
	a	With guidance, students describe* the desired features of the tool or object that would solve the problem, based on scientific information, materials available, and potential related benefits to people and other living things.

K-2-ETS1-3 Engineering Design

Students who demonstrate understanding can:

K-2-ETS1-3. **Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Analyze data from tests of an object or tool to determine if it works as intended.	**ETS1.C: Optimizing the Design Solution** • Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	

Observable features of the student performance by the end of the grade:		
1	Organizing data	
	a	With guidance, students use graphical displays (e.g., tables, pictographs, line plots) to organize given data from tests of two objects, including data about the features and relative performance of each solution.
2	Identifying relationships	
	a	Students use their organization of the data to find patterns in the data, including:
		i. How each of the objects performed, relative to:
		1. The other object.
		2. The intended performance.
		ii. How various features (e.g., shape, thickness) of the objects relate to their performance (e.g., speed, strength).
3	Interpreting data	
	a	Students use the patterns they found in object performance to describe*:
		i. The way (e.g., physical process, qualities of the solution) each object will solve the problem.
		ii. The strengths and weaknesses of each design.
		iii. Which object is better suited to the desired function, if both solve the problem.