Pushes and Pulls Coherence Flowchart

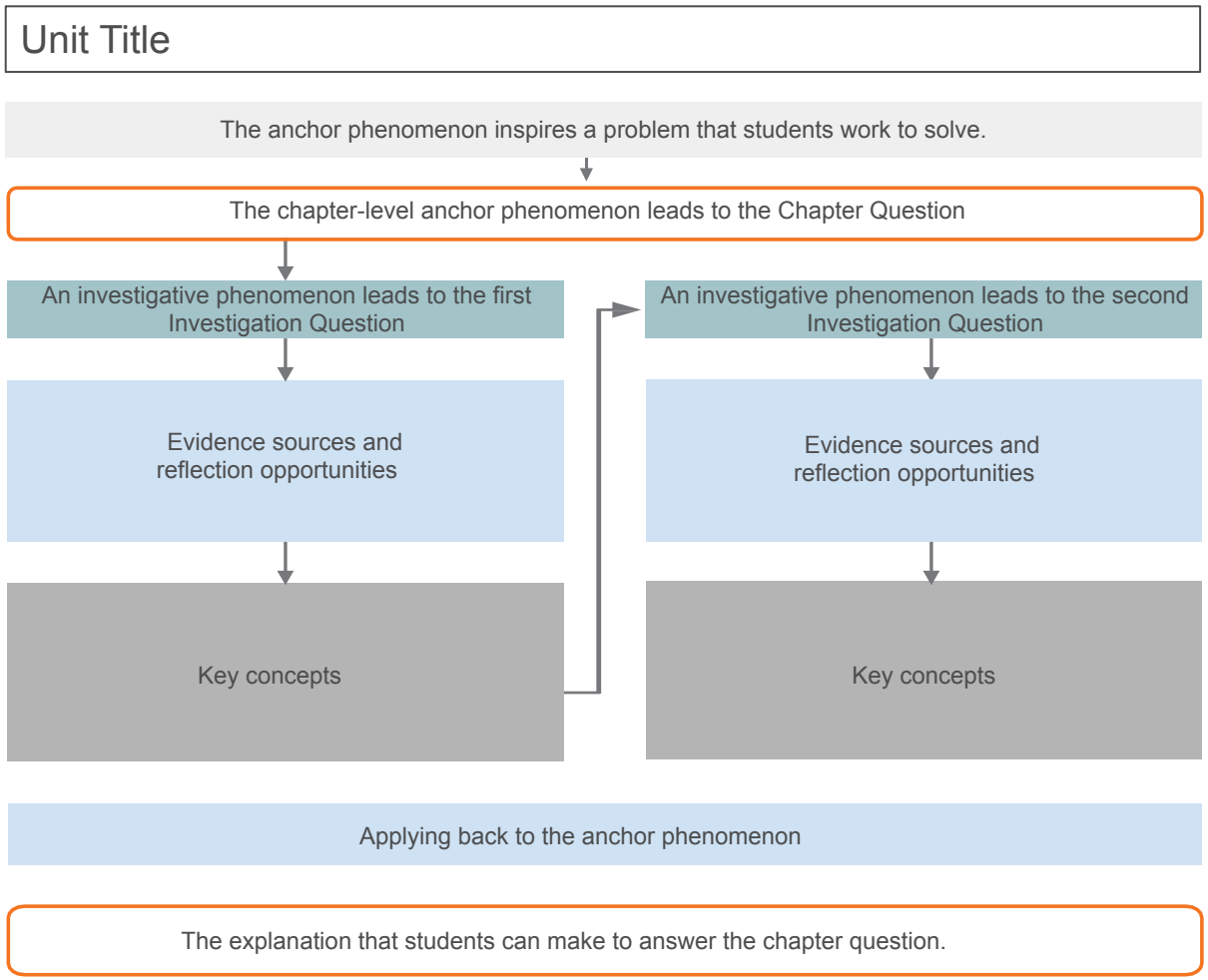
The storyline of the unit

In each Amplify Science unit, students figure out a phenomenon by asking questions, gathering evidence, and coming up with an explanation of how the phenomenon works. The Coherence Flowchart visually represents the storyline of the unit, showing the coherent flow of questions based on phenomena, evidence, and ideas that support students as they build complex explanations of the unit's anchor phenomenon. The Coherence Flowchart on the following pages (one chapter per page) can be used to see the connections between the phenomena and questions that drive students' experiences, the evidence they gather, the ideas they figure out, and the new questions that those ideas generate. The diagram to the right explains the structure of a chapter in the Coherence Flowchart.

In some units a design problem drives the investigations of the unit or of specific lessons. In these cases the design problem will be noted in place of the phenomenon.

Note: The Coherence Flowchart is a tool for teachers and is not meant to be distributed to students.

Typical structure of one chapter in a Coherence Flowchart



Instruction is framed by questions about the unit's anchor phenomenon and the related problem students are solving. Chapter Questions then guide students in figuring out the phenomenon, piece by piece. Within each chapter, investigative phenomena lead to Investigation Questions that focus students on a manageable piece of content that will help them figure out the Chapter Question. Each phenomenon leads to a question which motivates activities, and each activity provides specific evidence related to the Investigation Question. Students synthesize the understanding constructed over multiple activities, and this understanding is formalized through key concepts. Often a key concept leads students to an additional investigative phenomenon and Investigation Question students need to pursue to answer the Chapter Question. At the end of the chapter, students' new understanding is applied back to the unit's anchor phenomenon and leads students to a new Chapter Question or a final explanation.

AmplifyScience

Pushes and Pulls: Designing a Pinball Machine

Unit Design Problem

Problem students work to solve

We want to create a pinball machine that lets us control the way a pinball moves.
How can we create a pinball machine for our class?

Chapter-level Anchor Phenomenon
Chapter 1 Question

Sometimes a pinball starts to move.
How do we make a pinball start to move?

Investigative Phenomena
Investigation Questions

Sometimes an object starts to move.

What makes an object start to move? (1.1-1.4)

Evidence sources and reflection opportunities

- Investigate how to make objects start to move in a classroom Movement Hunt (1.1)
- Investigate making an object start to move in full-class Rugball routine (1.2)
- Use recognizable images of objects moving to visualize movement (1.2)
- Practice using cause and effect to explain everyday scenarios (1.2)
- Read Talking About Forces (1.2)
- Investigate how to make an object move by exerting a force on it using Forces Investigation materials (1.3)
- Use Explanation Language Frame to explain forces and movement in Forces Investigation (1.3)

Key concepts

- An object starts to move when another object exerts a force on it. (1.3)
- Forces happen between two objects. (1.3)

Application of key concepts to problem

- Design launchers to make a pinball start to move in individual student Box Models (1.4)
- Diagram Box Model launcher design (1.4)
- Add a launcher to make the pinball start to move in Class Pinball Machine (1.5)
- Shared Writing to explain the Chapter 1 Question (1.5)
- Revisit Talking About Forces to use Explanation Language Frame to explain how objects move in the text (1.5)

Explanation that students can make to answer the Chapter 1 Question

To make our pinball start to move, we must exert a force on the pinball. We can use a rubber band launcher to exert a force on the pinball.

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Unit Design Problem

Problem students work to solve

We want to create a pinball machine that lets us control the way a pinball moves.
How can we create a pinball machine for our class?

Chapter-level Anchor Phenomenon
Chapter 2 Question

Sometimes pinballs move different distances.
How do we make a pinball move as far as we want?

Investigative Phenomena
Investigation Questions

Sometimes objects move different distances.

What makes an object move shorter or longer distances? (2.1-2.3)

Evidence sources and reflection opportunities

- Engage in Embodied Forces Routine to practice moving short and long distances (2.1)
- Investigate how to make a tennis ball move a short distance and a long distance in partners (2.1)
- Investigate making an object move short and long distances in full-class Rugball routine (2.1)
- Read Forces in Ball Games to find out about strong and gentle forces in sports (2.2)
- Practice exerting strong and gentle forces in full-class Rugball routine (2.2)
- Sort images of objects moving based on the strength of the force exerted (2.2)
- Use Explanation Language Frame to explain forces exerted in images from the sort (2.2)

Key concepts

- An object moves a long distance when a strong force is exerted on it. (2.2)
- An object moves a short distance when a gentle force is exerted on it. (2.2)

Application of key concepts to problem

- Add shoelaces to student Box Models to control the strength of the forces the launchers exert (2.3)
- Diagram modified Box Model launcher designs (2.3)
- Modify Class Pinball Machine launcher (2.3)
- Shared Writing to explain the Chapter 2 Question (2.3)

Explanation that students can make to answer the Chapter 2 Question

To make our pinball go the distance we want, the rubber band launcher has to exert a strong force. To make it go a short distance, the rubber band launcher has to exert a gentle force. Attaching a shoelace to the rubber band launcher can help us adjust the force.

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Unit Design Problem

Problem students work to solve

We want to create a pinball machine that lets us control the way a pinball moves.
How can we create a pinball machine for our class?

Chapter-level Anchor Phenomenon
Chapter 3 Question

Sometimes pinballs move different directions and to different places.
How do we make a pinball move to a certain place?

Investigative Phenomena
Investigation Questions

Sometimes objects move in different directions.

What makes an object start moving in a certain direction? (3.1-3.2)

Sometimes objects move to different places.

What makes an object move to a certain place? (3.3-3.5)

Evidence sources and reflection opportunities

- Investigate how to make a tennis ball move in different directions in small groups (3.1)
- Investigate making an object move in different directions in full-class Rugball routine (3.1)
- Use images in Building with Forces to visualize making
- objects move in different directions (3.1)
- Read Building with Forces (3.2)
- Use Explanation Language Frame to explain movement in images from Building with Forces (3.2)
- Use shoelaces in student Box Models to control the direction of the force the launcher exerts (3.2)

- Investigate how to make a tennis ball move to a target in partners (3.3)
- Investigate making an object move to a certain place in full-class Rugball routine (3.3)
- Predict direction and strength of force required to
- hit a target, and then test predictions (3.3)
- Use Explanation Language Frame to explain how to move an object to a certain place (3.4)

Key concepts

- An object starts to move in the same direction as the force that starts the motion. (3.2)

- Every force has a strength—gentle or strong—and a direction. (3.3)
- Every force has a strength—gentle or strong—and
- a direction, which makes the object move a certain distance and direction. (3.4)

Application of key concepts to problem

- Control direction and strength exerted by the launcher to move a pinball to a target in student Box Models (3.4)
- Diagram how to move the pinball to a target in student Box Models (3.4)
- Make the pinball move to a target in Class Pinball Machine (3.5)
- Shared Writing to explain the Chapter 3 Question (3.5)
- Revisit Forces in Ball Games to explain how objects move to a specific place (3.5)

Explanation that students can make to answer the Chapter 3 Question

To get the pinball moving in the direction we want (left or right), we must exert a force on the pinball in the direction that we want it to move.

Pushes and Pulls: Designing a Pinball Machine

Unit Design Problem

Problem students work to solve

We want to create a pinball machine that lets us control the way a pinball moves.
How can we create a pinball machine for our class?

Chapter-level Anchor Phenomenon
Chapter 4 Question

Sometimes pinballs change direction.
How do we make a moving pinball change direction?

Investigative Phenomena
Investigation Questions

Sometimes moving objects can change direction.

What can make a moving object change direction? (4.1-4.2)

Evidence sources and reflection opportunities

- Investigate how to make a moving tennis ball change direction in partners (4.1)
- Investigate making a moving object change direction in full-class Rugball routine (4.1)
- Engage in Embodied Forces Routine to practice changing direction (4.1)
- Read about moving objects changing direction in Forces in Ball Games (4.2)
- Use Explanation Language Frame to explain how the moving Rugball, and moving balls in Forces in Ball Games, change direction (4.2)

Key concepts

- A moving object changes direction when another moving object exerts a force on it. (4.2)
- A moving object changes direction when a still object in its way exerts a force on it. (4.2)

Application of key concepts to problem

- Add flippers and bumpers to student Box Models to change a moving pinball's direction (4.3)
- Diagram modified Box Model launcher design (2.3)
- Modify Class Pinball Machine to add flippers and bumpers (4.3)
- Shared Writing to explain the Chapter 4 Question (4.3)

Explanation that students can make to answer the Chapter 4 Question

To make a moving pinball change direction, we have to exert another force on it, either from a moving object or from a still object in its path.

Pushes and Pulls: Designing a Pinball Machine

Unit Design Problem

Problem students work to solve

We want to create a pinball machine that lets us control the way a pinball moves.
How can we create a pinball machine for our class?

Chapter-level Design Problem
Chapter 5 Question

We want to create a pinball machine that lets us control the way a pinball moves.
How can we make the pinball machine do all the things we want it to do?

Investigative Phenomena
Investigation Questions

Engineers construct solutions that do what they want them to do,

How do engineers make their solutions do all the things they want them to do? (5.1)

Opportunities to engage in practices and apply key concepts

- Read about designing solutions in Room 4 Has a Problem (5.1)
- Create diagrams to plan student Box Model design based on Pinball Machine Design Goals (5.1)
- Based on diagrammed plans, update student Box Model design (5.1)
- Read about testing and updating designed solutions in Room 4 Solves a Problem (5.2)
- Test student Box Model designs and revise as necessary (5.2)
- Write to explain forces in pinball in How to Play Pinball with Forces mini-book (5.2- 5.3)
- Share and explain student Box Models in Box Model Showcase (5.3)
- Modify Class Pinball Machine to meet Pinball Machine Design Goals (5.3)

Practice that students can do in response to the Chapter 5 Question

Students can more independently construct a solution to a problem by planning and constructing solutions based on what they've learned, then testing, evaluating, and revising their solution to better meet design goals.

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Unit Anchor Phenomenon

Another problem students work to solve

Things all around us start moving, change direction, or stop moving.
How do we recognize forces in the world?

Chapter-level Anchor Phenomenon
Chapter 6 Question

Objects in Pushville and in our school start moving, change direction, or stop moving.
Where are forces around us?

Investigation Question

The world is full of things that start moving, change direction, or stop moving.

Where are forces in the world? (6.1)

Evidence sources and reflection opportunities

- Brainstorm where students can find evidence of forces being exerted (6.1)
- Use images in A Busy Day in Pushville to visualize forces being exerted and evidence of those forces (6.1)

Key concept

- Whenever we see an object start to move, stop moving, or change direction, that is evidence that something exerted a force on it. (6.1)

Application of key concepts to problem

- Investigate evidence of forces at school on School Forces Tour (6.1)
- Use Explanation Language Frame to explain evidence of forces on School Forces Tour (6.2)
- Read A Busy Day in Pushville (6.2)

Explanation that students can make to answer the Chapter 6 Question

There are strong and gentle forces in different directions all around us. We know a force has been exerted on an object whenever that object starts moving, changes direction, or stops moving.