Design Technology in Engineering Education for English Learners: Project DTEEL

NSF DRK-12 # 1503428

University of Texas, Austin

Third Grade
Lesson Plans
Units 1-9

DTEEL Third Grade Lessons

Unit 1 (Materials):
Changing Materials

Concept Different tools are used to change different materials.

Content Objectives
Students will identify the characteristics and common uses of tools such as scissors and hand drills.
Students will understand how tools can be used to change materials to make them better fit for certain tasks.
Students will categorize materials according to the tools that can be used with them.

Language Objectives
Students will discuss and present on common tools and how they can be used at home and in their community.
Students will infer the name of a tool by reading written descriptions.
Students will produce visual and written descriptions of common tools.

Standards

- **NGSS:**
  - **K-2-ETS1-1**. Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool.
  - **K-2-ETS1-3**. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses
- **TEKS**
  - **1A** Demonstrate safe practices during classroom investigations.
  - **3D** Connect grade-level appropriate science concepts with the history of science.
  - **4A** Collect, record, and analyze information using tools.
  - **4B** Use safety equipment as appropriate, including safety goggles and gloves.
- **ELPS**
  - **1A** Use prior knowledge and experiences to understand meanings in English. [Prior knowledge]
  - **1C** Use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary.
  - **4F** Use visual and contextual support and support from peers and teachers to read grade-appropriate content area text, enhance and confirm understanding, and develop vocabulary, grasp of language structures, and background knowledge needed to comprehend increasingly challenging language
  - **4K** Demonstrate English comprehension and expand reading skills by employing analytical skills such as evaluating written information and performing critical analyses commensurate with content area and grade-level needs

Tools	Hand drill; Clamp; Hole Punch; Scissors; Hammer; Screwdriver; Saw
Materials	Soft wood pieces (Cedar, Bass); Clay; Foil; plastic scraps; paper; cardboard; Safety first! Buttons; Recycled items (e.g., butter tubs, plastic soda bottles, Styrofoam trays, milk jugs, cardboard tubes) Handouts **3.1.1-3.1.3**
Literature Connections	*Tool Book* by Gail Gibbons *The Toolbox* by Anne Harlow Rockwell *Whose Tools* by Toni Buzzeo *The Home Depot Big Book of Tools* by Kimberly Weinberger

Day 1: Engage/Explore Materials- Changing Materials

Teacher Says/Does	Student Says/Does	Language requirements
1. Introduce tools with a read aloud of the book of your choice related to construction or tools. 2. Ask students to brainstorm a list of different tools and what they're used for. Follow up by asking more about the tools, e.g. which tools have you seen at school? What do you use them for? Which tools have you seen your mom or dad use? 3. Distribute pictures from Handout **3.1.1** to student pairs so they discuss one tool and share out the way it is used. 4. Make a chart on the whiteboard or poster paper similar to the one on the "Uses of Tools" handout. Ask students to share about the kinds of tools and their uses in the read aloud and to connect them to life experiences. 5. Discuss what a hand drill and a clamp are used for.	Students share what they know about tools	• hand drill • tool

Day 2: Explore/explain Materials- Changing Materials

Teacher Says/Does	Student Says/Does	Language requirements
1. Allow students to examine some classroom objects, like scissors and a hole-punch, a piece of construction paper, a pencil sharpener, data projector, computer. Ask them to identify which of are tools, and which are not, and to explain their reasoning. 2. Lead a discussion about the characteristics of tools. Ask students to define the word TOOL. Write students' ideas and the definition of a tool on the board/projector. Have students work together to develop a class definition. ["TOOLS" are used to change a material in some way, such as scissors to cut paper (demonstrate)]. 3. Present samples (or pictures from the handout) of materials like cloth, plastic, foil, and cardboard to the class. 4. Ask students to turn to a partner and share what tools they would use to change each of the following materials: cloth, plastic, foil, and cardboard. Share out answers. 5. Tell students that they all will become engineers since an "ENGINEER" is a person who changes materials so that the materials become better fit for certain tasks. Refer to students as engineers from this point forward during the lesson. 6. Use Handout **3.1.1**, and have groups of students identify materials each tool could be used to change, e.g. they will recognize the "saw" will only work for objects made of wood. 7. Have each group present to the class sharing what they found. Use Handout **3.1.2** with templates to support students' responses if necessary.	Students construct a definition for the term tool *tool*, and examine tools and materials. Identify examples and nonexamples of tools. Justify reasoning. A tool is _____. _____ is a tool because _____. _____is not a tool, based on our definition, because _____.	

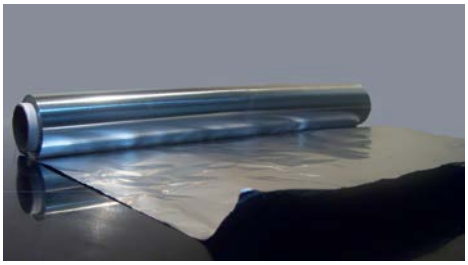
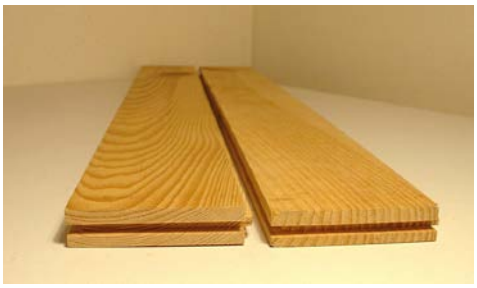
Day 3: Explore/ Explain (Optional activity at Woodworking Area) Materials- Changing Materials

Teacher Says/Does	Student Says/Does	Language requirements
1. Put on a *SAFETY FIRST button* to remind students to be careful when working in this area; *discuss* safety and the necessity of being calm and good listeners during this activity. 2. Tell students that they will need to listen very carefully. Provide specific instructions on how to hold and use the hammer. Have students discuss in partners and share their understanding of precautions with the rest of the class. Adapt and correct as necessary. 3. Demonstrate what happens when a hammer hits a piece of clay representing a finger, and then–if considered appropriate– have one student demonstrate how to hold a hammer properly and safely. 4. <u>If considered appropriate</u>, have all students try hammering piece of wood individually while you check their procedures such as safe placement of hands, use of clamp, etc. 5. Show the children how to use the adhesive, hand drill, stapler, and glue gun. Provide specific instructions for each one. If considered appropriate, let individual students try using each tool. 6. Use Handout **3.1.3** to have student pairs write down two precautions for each tool. Then, have each pair share with another pair. Discuss how important it is to take proper precautions when working with tools.	Students work at a woodworking area with tools and learn precautions when using them. We could use a hammer for____ We could use a drill for _____ A _____ would be a good tool to use on _____ if I wanted to _____. A _____ is not a good tool to use on _____.	precautions

Teacher Says/Does	Student Says/Does	Language requirements
7. Group Work: Provide a set of materials including cloth, plastic, foil and cardboard and a set of tools (could include scissors, crayons, hole-punch, duct tape or other strong tape, craft glue or wood glue) to each group of 4-5 students. Allow them to change each material with the different tools. 8. While groups are working independently, ask one group at a time if they would like to try to change one of their materials using either the hammer or the drill. 9. Come together after using tools. Have students share in partners: How did it feel to use the hammer? The drill? Why might we use a hammer? With which kinds of materials? Why might we use a drill? With which kinds of materials?		

Day 4: Elaborate/Evaluate Materials- Changing Materials

Extensions into the disciplines	Practical Extensions	Language requirements
1. Display the descriptions in handout **3.1.4**: guess the type of tool, do a choral reading of the descriptions, and have students guess the name of the tool. 2. Organize students in pairs and use the handout **3.1.5**: what would you use if you wanted to… Have students complete the handout. 3. Have students pick one favorite tool and write one paragraph describing its characteristics, how it is used, and safety rules tha are needed when using it. 4. Have groups give presentations to the class.	Students extend their conceptual understanding of tools and materials	

Material	Tool	What you do	Result
Paper	Scissors	cut	small pieces of paper
	Crayons		
	Tape		
	Whole-punch		
	Craft glue		

Sample sentence:

We can use scissors to cut paper and obtain small pieces of paper.

Taking Precautions with Tools

List two precautions to take when using each of the following tools.

	1. 2.
	1. 2.
	1. 2.
	1. 2.

Guess the Type of Tool

1. I am heavy. I make loud noises. I am used to hang up heavy things. I can't do it by myself though. I usually need a nail to help. What am I?

2. I am sharp. You have to be very careful using me. I am used to cut a lot of things, but mostly not so tough things like hair, paper, and cloth. What am I?

3. I do not work alone. I make your job a lot easier because you don't have to turn your arm too much when you use me. I am used to attach different materials to each other. My partner is a screw. What am I?

4. I am sharp. I have sharp teeth. I am used to cut wood. What am I?

5. If you ever want to put a piece of paper in a binder, you probably need to use me first. Some people have gotten creative with my design, so I no longer only create circles, but lots of different shapes. I work best with paper. What am I?

6. I am very small and skinny. I am helpful when you want to make sure that two or more pieces of paper stay together in a certain order. I am very common, but you may not have though of me as a tool before. What am I?

7. I am metal. I have a flat top and pointy bottom. I can help you create a movable pivot point between two materials like cardboard and construction paper. What am I?

8. I am used all over the place. I can attach paper to paper, paper to a wall, string to paper, string to a wall; all kinds of things. You don't really need a lot of me, and you have to be careful when you use me because sometimes, I stick to myself. What am I?

What would you use if you wanted to…?

Hang up a heavy mirror?	
Cut a piece of cloth?	
Attach a piece of metal to a piece of wood?	
Cut a piece of wood?	
Put a piece of paper in a binder?	
Attach two pieces of paper?	
Create a movable pivot point between cardboard and construction paper?	
Attach a piece of paper to a wall?	

Unit 2 (Materials):
Connecting Materials

Concept There are different ways to connect different materials.

Content Objectives Students will use adhesives, nuts and bolts, brass fasteners and tape to connect wood, cloth, plastic, foil, paper, plastic, and cardboard.
Students will learn how materials can be connected using connectors.
Students will learn basic features of fasteners and bolts.
Students will learn different ways in which materials can be connected.

Language Objectives Students will learn the meaning of the word connector
Students will use the words: connectors, fasteners, and bolts as part of oral discussions

Standards

- **NGSS**:
  - **K-2-ETS1-1**. Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool.
  - **K-2-ETS1-2**. Make a drawing or physical model to illustrate how the shape of an object helps it to solve a problem.
  - **K-2-ETS1-3**. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses

- **TEKS**
  - **1A** Demonstrates safe practices during classroom investigations.
  - **3D** Connect grade-level appropriate science concepts with the history of science.
  - **4A** Collect, record, and analyze information using tools.
  - **4B** Use safety equipment as appropriate, including safety goggles and gloves.

- **ELPS**:
  - **1C** Use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary. [Metacognitive Strategies]
  - **1H** Develop and expand repertoire of learning strategies such as reasoning inductively or deductively, looking for patterns in language, and analyzing sayings and expressions commensurate with grade level learning expectations

- **2D** Monitor understanding of spoken language during classroom instruction and interactions and seek clarification as needed [Comprehensible Input]
- **5B** Write using newly acquired basic vocabulary and content-based grade-level vocabulary

Tools	Hand drill; C-clamp; Hole punch; Scissors; tape dispensers; staplers; low temp glue gun
Materials	Wood; paper; cloth; foil; plastic; safety first buttons; white butcher paper (2 yards); recycled plastic items; Bolts; Paper Fasteners (i.e. brads) [Optional additional tools: Ratchet; grommet tool; riveter; soldering iron] Handouts **3.2.1-3.2.6**
Literature Connections	*Zip It* by Patricia Hegarty and Fhiona Galloway *Snap, Button, Zip: Invention to Keep Your Clothes On* by Vicki Cobb

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Look around the room. Point out places where two or more pieces of material are connected, such as buttons that connect parts of clothing, bolts that connect desk parts, glue that connects paper, and so on. Ask questions to promote a discussion about how these materials are connected. 2. Display or distribute a graphic organizer (see Handout **3.2.1**) and ask the students to turn to a partner, select three classroom materials that are connected, talk about the materials and how they are connected, and then share with the rest of the class. 3. Show samples of classroom materials that are not connected. Ask, "How might we connect cloth to wood?", and go through the foil, paper, wood, and other materials, writing down student ideas on an experience chart: 4. With samples in hand, introduce connecting objects such as: thread, paper fasteners (brads), glue, nails, screws, bolts, and hinges, and mention one property of each. 5. Discuss the difference between a fastener and a bolt, and fill in diagram on **3.2.1**. 6. Using Handout **3.2.2**, have each pair write about their materials, then pass their writing to the pair on the right. 7. Then, have pairs read the paragraphs given to them and share with the class one aspect of interest from another pair.	• Students talk about classroom materials that are connected • Students discuss differences between a fastener and a bolt	• Connectors • Fastener • Bolt

Day 2: Explore/Explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Give students Handout **3.2.3** for writing down precautions, and tell them that they will need to observe a demonstration and write down the main precautions taken. 2. Demonstrate safe use of the adhesive(s), stapler, hand drill, and low temperature glue gun. (If you choose to employ a hot melt glue gun in some of these activities, be sure the children know it is for teacher use only.) Whatever adhesive material you have, look at the list of ingredients and read them aloud. 3. Organize students in groups, and have each student read to members in a group what they wrote down, then have a discussion, and have them add in more observations. Have one member of each group present to the class. 4. Explain to students that sometimes things are connected when they are arranged together, such as shoelaces, Velcro, and latches. Tell them that sometimes there are things we want attached only part of the time. 5. Using Handout **3.2.4**, lead the class to identify examples of connections that allow movement, connections that allow unfastening without damage, and connections that can be re-fastened. 6. Have students form groups; have half the groups gather objects and classify them into connector categories, and the other half classify connectors into objects that go with them. Use a graphic organizer (see Handout **3.2.5** and **3.2.6**).	• Students learn about precautions when handling certain tools • Students learn about types of connectors and the materials that are associated with them	• connectors • fasteners • bolt • stapler • hand drill • glue gun • adhesive material

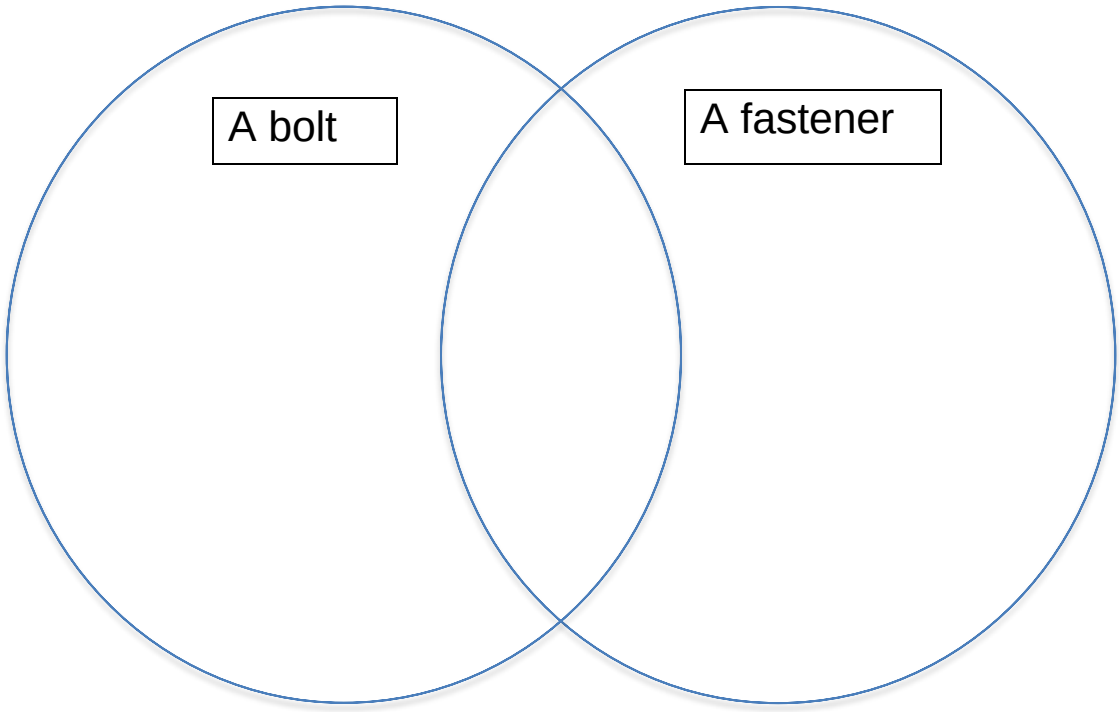
Day 3 Elaborate and evaluate

Extensions into the disciplines	Practical Extensions	Language requirements
1. Go on a tour of the school to see how different materials are connected. 2. Begin an experience chart by placing a sheet of butcher paper on the floor, or make labels of the headings shown: **Materials to connect** | **Tools and conn** i. 3. Have the children place the actual items on the floor chart. 4. Have the building supervisor or another technician come in and demonstrate how to connect different materials. You may also like to ask the art teacher in your school to talk about means of connecting craft materials. 5. Explain to the students that the Class Log will be used to document their activities and what they've learned. Begin writing in the Class Log: "Today we found out how to connect...," and write what connecting materials, tools and building materials were used. Also let them tell you what to write concerning teamwork: "Teams make us better workers because. . . " or some other generalization. 6. Have each student investigate in his or her houses for connectors-at least one connector per student, and bring back a drawing and an explanation of how it works. Organize presentations for students to share from their home and school investigations and share in class	Today we found out how to connect ____ and ____.	

Graphic organizer to collect student ideas as part of a whole-group discussion

Material 1	Material 2	How they are connected
Foil		
Paper		
Wood		

Comparing a bolt and a fastener



The two connected materials that we selected were _____and _____.
They are connected by a _____
Two materials that are connected by a fastener are_____and _____
Two materials that are connected by a bolt are_____and _____
One difference between a fastener and a bolt is _____

Our paragraph: _____ _____ _____

Handout for writing down precautions

	Write down precautions used by the teacher	
	Individual observation	After group discussion
Adhesive		
Stapler		
Hand drill		
Glue gun		

For whole group activity

Connected by being arranged together	
Connected by being attached	
Connections that allow movement	
Connections that allow fastening without damage	
Connections that can be re-fastened	

Sorting activity: choose three connector categories and identify materials that go with it

Connector category: _____	Connector category: _____	Connector category: _____
Materials :	Materials :	Materials :

Sorting activity: choose a material and then identify connectors that go with it

Type of material: _____	Type of material: _____	Type of material it can be used with: _____
Connectors	Connectors	Connectors

Unit 3 (Structures):
Models We Can Make

Concept Models are copies of objects; models help us plan how to make structures and other objects. Models have a scale, which helps us understand the size of the actual object being modeled.

Content Objectives Teams make a small model of a big structure and play a game guessing other teams' models.
Students will follow the steps of a design brief to design a model.
Students will apply principles of assessment to models created by other students.

Language Objectives Students will discuss and use the following terms as part of oral discussions: models, engineering design, design brief.
Students will describe a basic engineering model.
Students will understand the words prototype, specifications and process in written paragraphs.

Standards

- **NGSS**
  - **K-2-ETS1-2** Make a drawing or physical model to illustrate how the shape of an object helps it to solve a problem.

- **TEKS**
  - **3C** Represent the natural world using models and identify their limitations, including size, properties, and materials

- **ELPS**
  - **1C** Use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary. [Metacognitive Strategies]
  - **2D** Speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency [Application for Acquisition]
  - **3H** Narrate, describe, and explain with increasing specificity and detail as more English is acquired. Read silently with increasing ease and comprehension for longer periods

- **4F** Use visual and contextual support and support from peers and teachers to read grade-appropriate content area text, enhance and confirm understanding, and develop vocabulary, grasp of language structures, and background knowledge needed to comprehend increasingly challenging language

Tools	Wheels and craft sticks
Materials	Access to all construction materials, such as glue, string, wood pieces, cloth, etc. Access to recycled materials of choice. Handouts **3.3.1-3.3.5** Design Brief **3.3.4** copied onto a chart for the class to see.
Literature Conncetions	*The Legos Idea Book: Unlock Your Imagination*

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Present the four questions about models in **3.3.1** to students. Have students work in pairs and respond to the first question, by defining in their own words what models are. Proceed to the second question and have them discuss if any of them have hobbies in which they work with models. Similarly, ask student pairs to find one or two examples of models in the classroom. Show the students sample car models and have them look around the room and in other places to find other models. Finally, ask them to share their ideas of how models of cars can help car builders. Discuss with them that models can be smaller than the object of which they are copies, and show and talk about examples. Pass out a copy of the card phrases **3.3.2** to each student pair, and have them construct a paragraph about the process of engineering design using the phrases in the handout. Once the paragraph is constructed, have student pairs compare the paragraphs they came up with with outher teams. Encourage them to pause after each phrase, and make comments about word meanings **3.3.3**. ❖ For a class with struggling readers and writers, you may construct the paragraph as a whole group and discuss the meaning in more depth.	Students answer questions about models Students construct a paragraph about the process of engineering design	• Models • Engineering design • Design brief • Prototype • Specifications • Process

Day 2: Explore/Explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Show the students the Design Brief **3.3.4**. Explain that a Design Brief is a problem for their team to solve. To begin solving a Design Brief problem, they need to read the specifications, and think about how they would meet them. 2. Organize students in pairs or groups as convenient. Give each pair/group a copy of the card with the description of the design brief. Discuss and display the following steps to support their work: • Read the Design Brief. • Ask questions about what the words mean. • Once you understand what the words in the Design Brief mean, talk with your partner and plan what you might make. • Students will make several preliminary sketches, select one, and make a labeled sketch to present to the class. • Either using cut pieces of paper or drawing, make a plan for the car you will make. Discuss who will do which job, and how you will make sure both people have interesting jobs. 3. Have teams start building a model of their car. 4. When the student teams have worked on the task, have them tell you about their planning, the steps they have followed, about their ideas and how they worked together as a group. Check to be sure they understand the word "model," and that they are making a small model of a big thing. 5. Have the teams dictate to you a description of their model. In the description they should tell where their ideas came from. Give feedback as appropriate.	Students ask and answer questions about the Design Brief	Design Brief We followed the following steps: First, we _____ Then, we_____ Finally, we_____

Day 3 Elaborate and Evaluate

Extensions into the disciplines	Practical Extensions	Language requirements
1. Have each team present their model to you and to the class, in order to get a friendly review from their classmates. Ask each team to address the following in their presentation: • *how they selected their model* • *the steps they followed* • *how they worked together* • *where their ideas came from* • *the size of their model.* Ask the other teams to each ask at least one question for the presenting team to answer as part of the design review. Make sure that the criteria above (underlined) are part of the discussion and review. 2. Place the models in the Design Gallery, located where other classes can see the work, especially classes who will be involved in the Technology Fair. 3. Students should then evaluate their planning and teamwork. A class discussion should take place on the following points (see handout for evaluating the work **3.3.5**): • Did the team make a small model of a big thing? • Did the team follow the rules given in the Design Brief? • Where are the natural materials? Where are the synthetic materials? • Who used teamwork? Who had good ideas? Who shared ideas?	Students present their sketches to their classmates and answer questions as part of a design review Students evaluate their planning and their teamwork	

What are models?
Have you ever worked with models?
What are examples of models in our classroom?
How do models help people who build cars?

Cards for activity to construct a paragraph about what engineering design is:

Engineering design is	the process of devising a system
to meet desired needs.	It is a decision-making process.
The design process	involves several steps:
beginning with asking questions,	in order to clarify the problem,
planning and creating a model,	and testing a prototype
against the specifications in the design brief.	

Engineering design is the process of devising a system to meet desired needs. It is a decision-making process. The design process involves several steps: beginning with asking questions, in order to clarify the problem, planning and creating a model, and testing a prototype against the specifications in the design brief.

Design Brief Description
Goal: Design and make a model of a car
Specifications and Constraints: -You must use materials available to everyone. -You should draw and label your plan and present it in a design review. -You should get approval before you begin. -You should practice safety at all times.

Assessing the design of the model.

	To some degree	To a moderate degree	To a large degree
CONTENT			
(Used recycled material)[1]			
(Used synthetic materials)			
(Used natural materials)			
SKILLS			
(Worked well in a team)			
(Presented ideas and product to the class)			
(Participated in a design review)			
(Helps clean up)			
PRODUCT			
(The model works)			
(A drawing of the design was presented)			
(Team met the constraints of time)			
TOTAL POINTS			

[1] The criteria in parenthesis should be replaced with ideas from students.

Unit 4 (Structures): See-Saw Shoe Mobile

Concept Balance of a structure relates to distribution of forces.

Content Objectives Students experiment with finding balancing points on a big mobile and draw free-body diagrams showing forces.
Students will analyze different situations that need balance and construct a shoe mobile to experiment with balance, as well as pulling and pushing forces.
Students analyze distance of an object to the fulcrum as part of balance

Language Objectives Students will write paragraphs reflecting an understanding of the concept of balance in everyday and in engineering contexts.
Students will discuss the properties of a free-body diagram in groups.
Students will write paragraphs using the words fulcrum and balanced systems.

Standards

- **NGSS**:
  - **K-2-ETS1-2.** Make a drawing or physical model to illustrate how the shape of an object helps it to solve a problem.

- **TEKS**
  - **2C** Construct graphic organizers using tools and current technology to organize, examine, and evaluate measured data
  - **3A** Analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing
  - **6B** Demonstrate and observe how position and motion can be changed by pushing and pulling objects to show work being done such as swings, balls, pulleys, and wagons

- **ELPS**:
  - **3E** Share information in cooperative learning interactions [Communicative Competence]
  - **5B** Write using newly acquired basic vocabulary and content-based grade-level vocabulary
  - **5G** Narrate, describe, and explain with increasing specificity and detail to fulfill content area writing needs as more English is acquired

Tools Materials Rods or strips about 12-18” long for making group mobiles; Broomstick/ thick dowel rods; foam board or cardboard strips with holes evenly spaced; string; curtain hooks to

	hang shoes on mobile rod; children's lace up shoes; team mobile sticks (e.g. pencils, dowels, stiff rolled paper tubes, coat hanger wires); Metric rulers or yardsticks; math balance (i.e., equal arm balance numbered 0-10 in either direction from the balance point of 0.) Handouts **3.4.1-3.4.3**
Literature Conncetions	*Ten Apples on Top* by Dr. Seuss

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Tell students you will be investigating and discussing balance. Write the word "balance" on the board. 2. Ask if they have been on a seesaw before, and have someone draw it on the board. What are some interesting things to do on a see saw? Ask students to share a past experience with a seesaw and how balance was attained. How does something behave if it's "off-balance?" Give opportunities for two or three responses. 3. Ask whether they have examples of things that are said to be "balanced." We talk about the balance of nature, a well-balanced meal, a bank balance, and even balanced people. 4. Working in pairs, or as a whole group, distribute the handout with exploratory questions about balance **3.4.1**. Ask students to read all five paragraphs, and to write a paragraph using the word balance to answer the questions in the space provided. Give a few minutes and then ask pairs to share with the rest of the class. The pair member who didn't write should read when sharing with the rest of the class. 5. Hold up a length of a dowel rod or broomstick and challenge students to try to hold the entire rod on one finger. How can it be done? What happens if the finger is moved one way or the other? Write down their words and ideas as they describe the action of the stick leaning one way or the other. Can they find the center of balance? 6. Have student pairs discuss the different way in which the concept of balance is used with the rod or broomstick and that which they used in their paragraphs in the engage/explore part of the lesson	Students share past experiences involving balance Students read and write paragraphs about balance Students discuss the concept of balance	Vocabulary: • Balance • dowel rod • broomstick

Day 2: Explore/explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Ask students if they can think of a way to make a team mobile that shows a balance of some sort. 2. Tie a broomstick or rod to a string hanging from the ceiling or a chart rack. Be sure the knot in the center is loose enough for you to slide the stick around. Have one child come up and find the right place to place the string so that the rod is balanced. 3. Give a few minutes for student pairs or teams to discuss how you decide where to put the rod, and have them share with the class. 4. When the rod is balanced (roughly), tape the string to it. 5. Ask the children to tie their shoes in different places along the rod, observing the action. Encourage them to try all different combinations of shoes, such as three shoes hanging together on one spot, or spread out along the same side of the center point. 6. Draw a sketch of the rod hanging from a string, balanced. Ask the children to come draw arrows to represent the forces of gravity pulling down and the reacting force of the string pulling up on the rod. 7. Tell them that by showing the pushing or pulling forces with arrows, they have created what engineers call "free-body diagrams," sketches that show the forces acting on a structure. 8. Have student pairs/teams discuss a free-body diagram that they might like to design.	Students discuss ways to make mobiles Students discuss free-body diagrams that they might like to design	• Free-body diagram • sketches • fulcrum • weights • advantage

Teacher Says/Does	Student Says/Does	Language requirements
9. Let the students add additional rods and shoes to the shoe-mobile. Then, have them draw, in teams, a free-body diagram. 10. Initiate a discussion with the students about balance. Show them a moveable math balance and ask them to demonstrate how you can balance something heavy such as two 10-gram weights with one-10 gram weight, depending on the distance from the fulcrum (balance point.) The numbers on the math balance make it especially useful for showing the advantage one gets by using distance from fulcrum. Ask students to show several ways they could balance a heavy shoe with two lightweight shoes (they could use a fulcrum that is closer to the heavy shoe, for example). 11. Ask student pairs or teams to examine the words on handout **3.4.2**, discuss them, and write a paragraph so that all words are used.		

Day 3 Elaborate and evaluate

Extensions into the disciplines	Student Says/Does	Language requirements
1. Let teams work on their own to draw and discuss some ideas and then make simple mobiles that are models of things in balance. 2. Provide access to construction materials and assist where necessary. Share ideas on mobiles that are models of systems in balance, like: balancing containers of ounce-capacity on one side and gallon capacity on the other side. 3. When teams have finished a mobile, they should explain: • What system they have modeled in their mobile? • Why they put fulcrums where they did? • Which items needed to be closer to fulcrums and which farther? 4. Have students discuss in pairs or teams the answers to the above questions. Then, have them write their answers by completing the sentence stems provided in handout **3.4.3**. Last, have one team read a question and then a student pair or team read the answers to the class, until all questions are addressed.	Students discuss ideas about mobiles that balance Students discuss questions about mobiles and balance	Vocabulary: ***Brick words:*** Balance Mobiles Fulcrum ***Mortar words:***

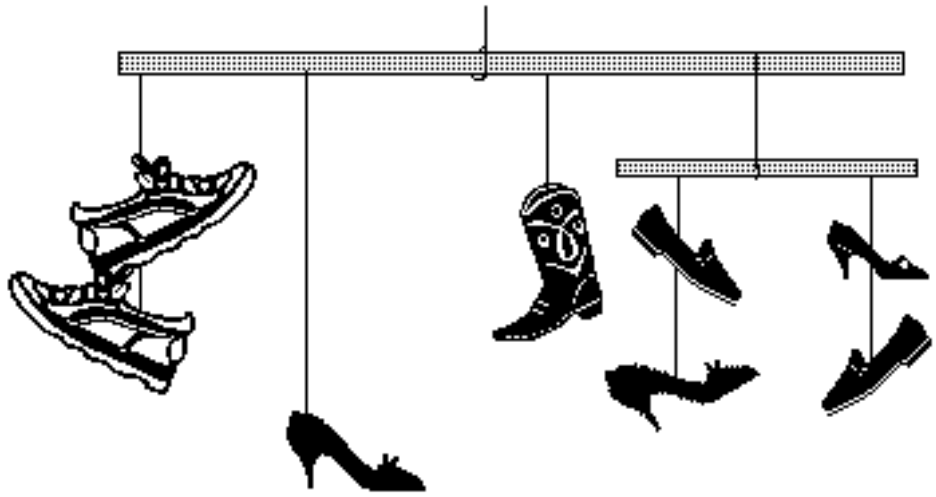
What is a balanced diet or a balanced meal? What happens if we don't eat balanced diets?

How do tight-rope walkers keep their balance? How does carrying a long pole help them? What factors can make them lose their balance?

How are designs balanced in clothes? For example, in fabric that is decorated with huge flowers, how are they spaced to give a balanced effect? Can you think of a design that is out of balance?

Have you ever used a balance beam? How about using a balanced beam with your eyes closed? How do you attain balance in a balance beam? Is it easy or difficult to have balance on a balance beam? Why or why not?

Why do you think balance important for health and for posture, and especially as one gets older?



Free-body diagram	weights	fulcrum	advantage
mobile	depending on	design	balance
_____ _____ _____			
_____ _____ _____			
_____ _____ _____			

The type of balanced system that we modeled in our mobile is_____ _____
We put the fulcrum on_____ because_____
The _____ needed to be closer to the fulcrum because_____
The _____ needed to be farther from the fulcrum because_____

Unit 5: (Structures):
Stable Structures–Pigsworth Construction Company[1]

Concept Structures need to be in equilibrium with forces in order to be stable.

Content Objective Students explore with simple structures and design stable structures that do not blow over in heavy winds.

Language Objectives Students will listen and write ideas from classroom discussions using grade-level vocabulary
Students will expand their receptive vocabulary with technical words like: Design brief, specifications requirements, labeled sketch, structure, distance, fan speed and constraint.

Standards

- **NGSS**
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool.
  - **K-2-ETS1-2.** Make a drawing or physical model to illustrate how the shape of an object helps it to solve a problem.
  - **K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses.

- **TEKS**
  - **3C** Represent the natural world using models and identify their limitations, including size, properties, and materials
  - **6B** Demonstrate and observe how position and motion can be changed by pushing and pulling objects to show work being done such as swings, balls, pulleys, and wagons

- **ELPS**
  - **3H** Narrate, describe, and explain with increasing specificity and detail as more English is acquired.
  - **4F** use visual and contextual support and support from peers and teachers to read grade-appropriate content area text, enhance and confirm understanding, and develop vocabulary, grasp of language structures, and background knowledge needed to comprehend increasingly challenging

[1] NOTE: Thanks to Paul Wayne of Round Rock ISD, the first DTEACher to use the story of the Three Little Pigs as the context for this design challenge.

language
- **5G** Narrate, describe, and explain with increasing specificity and detail to fulfill content area writing needs as more English is acquired.

Tools Materials	Construction materials for structures: white copy paper to be rolled and taped; toothpicks and connectors (e.g., clay, playdough); spaghetti noodles and masking tape; straws and paperclips; construction paper; table or floor fan Handouts **3.5.1-3.5.4**
Literature Connections	*The Three Little Pigs, Building a House* by Byron Barton *How a House is Built* by Gail Gibbons

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Ask students to share their recollection of the story of the *The Three Little Pigs.* Have students retell the story. Discuss the structures of the three houses the pigs made. Distribute handout **3.5.1** with questions to students and ask them to think of answers to each of the following questions: • Why was the wolf able to blow down the house that was made of straw? • What makes a material strong? • Why did they get blown over? • Which way was the force of the wolf breath pushing on the structure?	Students discuss and answer questions about the story "The Three Little Pigs"	Free-body diagram
2. Give a few minutes for discussions, and then have student pairs share their ideas with the rest of the class. Tell students to write down ideas from the class discussion and to complete answering the questions in the handout individually.	Students write answers to questions about the story	
3. Draw a simple free body diagram of a pig house and show it to students, without telling students that it is a free body diagram. Ask students to tell you the word that describes your drawing, and to give another characteristic of a free-body diagram.		
4. Ask student pairs to draw the free-body diagram (**3.5.2**) of the pig house. Ask students how they would draw the force of the wolf's breath. Complete the free-body diagram with students' ideas. Have each student complete the free-body diagram for one of the pigs' houses and share a comment about their drawing.	Students draw a free-body diagram based on the story	

Day 2: Explore/ Explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Show students the design brief (**3.5.3**). Explain to them that a Design Brief is a problem for their team to solve, and that to begin solving a Design Brief problem they need to read the specifications and think about it. 2. Ask the students what a stable house needs, and adapt the design specifications in the handout based on the discussion. 3. Consider the following additional requirements: a. The pig house must be stable b. It must be standing in the same place after a wind has blown on it. 4. Show students the fan that will be the wolf breath. Have them decide with you how the fan will be placed for testing their houses (distance, fan speed, etc.) Point out to them that they want the test to be fair, that each house will be subjected to the same amount of force. 5. You may wish to add a constraint that the houses are about the same size. You can do this by saying that the "footprint" of the house be not bigger than 6" by 6" (15 cm x 15 cm). This means that the base of the house will fit exactly onto a square that size. You may also wish to have a height limitation. 6. You also should decide if the houses will need paper walls or can be just a frame. As you can see, a paper-walled house offers more wind resistance and might be moved more easily. Be sure the students help make and understand the decision about walls.	Students discuss ideas about what makes a stable house Students plan models based on the design brief	• Design brief • specifications • requirements • labeled sketch • structure • distance • fan speed • constraint

Teacher Says/Does	Student Says/Does	Language requirements
7. Organize students in pairs or groups as convenient. Give each pair/group a copy of the card with the description of the design brief. Have them read the Design Brief (in the handouts), and talk with partners or within their groups to resolve any meanings, and plan who will do the different jobs. 8. Have teams start creating a plan for their model. Tell them to make several preliminary sketches, select one, and make a labeled sketch to present to the class. 9. Let teams work on their houses and then test them.		

Day 3: Explore/Explain

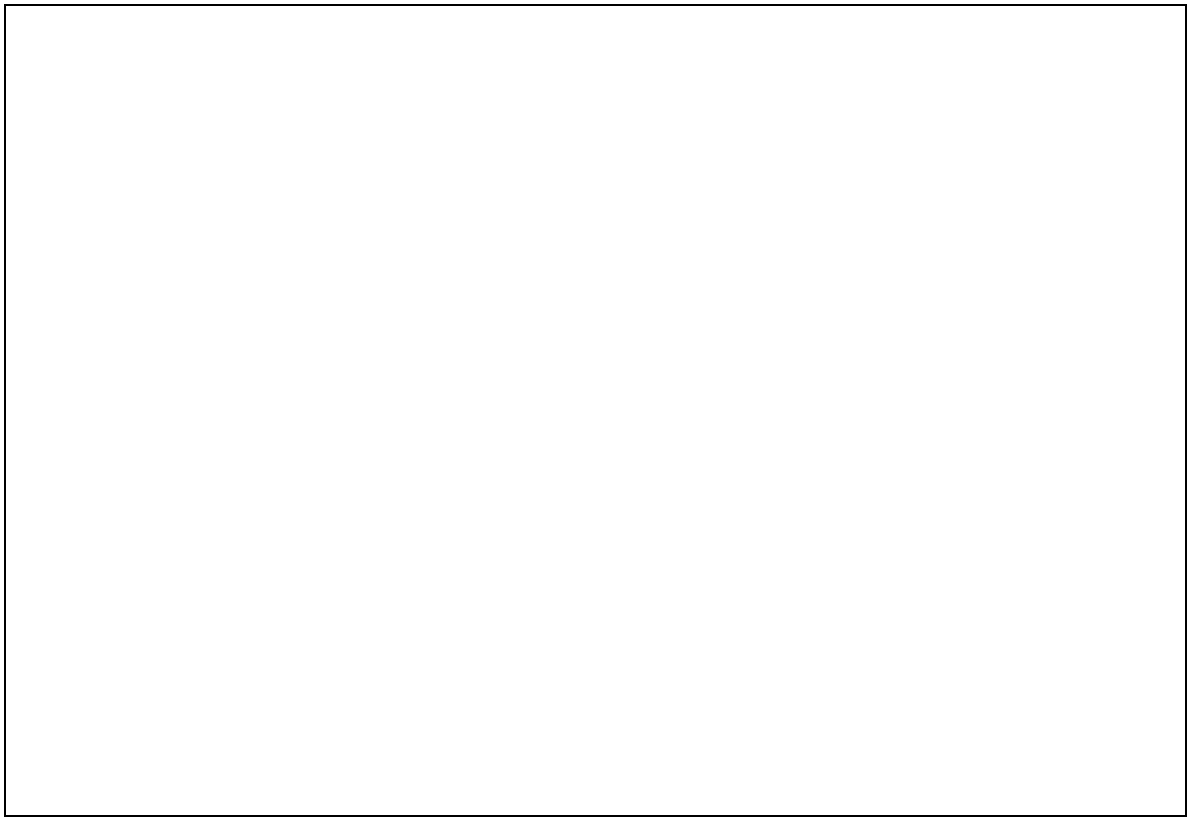
Teacher Says/Does	Student Says/Does	Language requirements
1. Have pairs or teams use a graphic organizer (see **3.5.4** for notes on our design) for writing down characteristics of their design, and the results of their testing. 2. Organize presentations from each pair of students or from each team to talk freely about their design and about the result of their testing. Have them share their ideas to the class and get feedback. 3. Here are some questions to ask during the de-briefing: a. -How stable was your pig's house during the wolf breath test? b. -What were some ideas you had that changed during the construction of your house? c. -How did your team share ideas and work together? d. -In what ways is your house a model? 4. Then have them write their ideas on the third category: Feedback from the Classroom Discussion. 5. Student teams should dictate or write a log entry that describes the project and the stability of their structures.	Students use a graphic organizer to write characteristics of a design and discuss it with classmates	

Day 4 Elaborate and evaluate

Teacher Says/Does	Practical Extensions	Language requirements
1. Ask students to remember their free-body diagrams and the discussion about the houses from the Three Little Pigs, and ask them to discuss what makes a structure stable. Have them give examples of an unstable and a stable structure. 2. Show students the materials for building simple structures, using noodles, toothpicks, paper rolls, straws, and other materials. Let them spend an hour or two making a little house out of each structural material. Ask them to build structures that are stable. 3. When they have all had some experience with a variety of construction techniques, have them share what they have learned. You may wish to focus the discussion with these questions: • Which structures are more stable? why? • Which connectors worked best with noodles? Toothpicks? Paper rolls? Straws? • Which shapes (triangles, squares, circles) seem to make structures that are best balanced—that is, they do not easily fall over?	Students share examples and non-examples of a stable structure Students participate in a discussion about stability	Stable structures Connectors

Question for pair/share	Sentence stems for answers
What makes a material strong?	A material is strong when_____
Why was the wolf able to blow down the house that was made of straw?	The house of straw could be blown down because _____
Why did they some houses get blown over?	They got blown over because_____
Which way was the force of the wolf breath pushing on the structure?	The force of the wolf breath was pushing _____

My free body diagram of the pig's house made of _____



Design Brief Description (draft)
Goal: Design and a stable house for one of the pigs in the Three Little Pigs to protect him from the wolf.
Specifications and Constraints: -The pig house must be stable. -It must be standing in the same place after a wind has blown on it. -You must use materials available to everyone. -You should draw and label your plan and present it in a design review. -You should get approval before you begin. -You should practice safety at all times.

Main Characteristics of our Design	
Results of our Testing	
Feedback from the Classroom Discussion	

Assessing the design of the model.

	To some degree	To a moderate degree	To a large degree
CONTENT			
(Used recycled material)[1]			
(Used synthetic materials)			
(Used natural materials)			
SKILLS			
(Worked well in a team)			
(Presented ideas and product to the class)			
(Participated in a design review)			
(Helps clean up)			
PRODUCT			
(The model works)			
(A drawing of the design was presented)			
(Team met the constraints of time)			
TOTAL POINTS			

[1] The criteria in parenthesis should be replaced with ideas from students.

Unit 6 (Mechanisms):
Bean- Ho!

Concept Mechanisms can change the size of input movement; movement on one end of a lever depends on distance from pivot point.

Content Objective Teams use black box modeling to design and make a device that will launch a bean a distance of at least 5 meters.

Language Objectives Students will understand the meaning of the words *input, system of events,* and *output* using concrete examples.
Students will produce examples that fit the meaning of input, system of events, and output.
Students will use engineering vocabulary as part of cooperative discussions

Standards

- **NGSS**
  - **K-2-ETS1-2** Make a drawing or physical model to illustrate how the shape of an object helps it to solve a problem.

- **TEKS**
  - **2A** Plan and implement descriptive investigations, including asking and answering questions, making inferences, and selecting and using equipment or technology needed, to solve a specific problem in the natural world
  - **2B** Collect data by observing and measuring using the metric system and recognize differences between observed and measured data
  - **2E** Demonstrate that repeated investigations may increase the reliability of results
  - **2F** Communicate valid conclusions supported by data in writing, by drawing pictures, and
  - through verbal discussion
  - **4B** Use safety equipment as appropriate, including safety goggles and gloves
  - **6A** Explore different forms of energy, including mechanical, light, sound, and heat/thermal in everyday life
  - **6B** Demonstrate and observe how position and motion can be changed by pushing and pulling objects to show work being done such as swings, balls, pulleys, and wagons

- **ELPS**
  - **2E** Use visual, contextual, and linguistic support to enhance and confirm understanding of increasingly complex and elaborated spoken language [Context Clues]

- **3E** Share information in cooperative learning interactions [Communicative Competence]
- **3D** Speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency [Application for Acquisition]

Tools Materials	Black Box handouts **3.6.1** and cutouts of **3.6.2, 3.6.3**
Literature Connections	*The Knight and the Dragon* by Tomie DePaola

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Tell students that they will learn about devices that can throw small objects, like a bean, at a distance. Show them the *Marshmallow Catapult* video https://www.youtube.com/watch?v=R7hBg91_DZI 2. Have student pairs describe what they saw in the video 3. Explain to students that they will work with "Black Box" problems. These are problems that begin with one thing (called an "input"); something happens to it (called "a system of events"), and you end up with something different (called "an output"). 4. Use the handout **3.6.1** to give an example of an input: 2, a system of events: [X3], and an output: 6. 5. Have students use the cards in handout **3.6.2** to practice with another example. Then, have students generate their own examples of inputs, systems of events, and outputs and share them with the class. 6. Tell them that what they did is create what engineers call " mechanisms", processes and devices that convert something like a force into something else. 7. If considered appropriate, talk about examples of mechanisms in simple machines (lever, gear, pulley, wheel and axle, screw, and inclined plane).	Students discuss a video Students get familiar with black-box thinking	• input • system of events • output • mechanisms • Review: • lever • gear • pulley • wheel and axle • screw • inclined plane

Day 2: Explore/ Explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Show them the construction materials available and the Design Brief: **Design a device that will send a bean across a distance of at least 5 meters from where it starts.** 2. Remind the students of how to begin work on a Design Brief. 3. Ask questions about what the words mean. 4. When you understand what the words in the Design Brief mean, talk with your partner and plan what you might like to make. 5. Make a planning map and label who will do what jobs. 6. Draw a sketch that shows a side view of what your device will look like. Label the sketch with the materials you plan to use. 7. Consider asking students: "What do you think a side-view sketch is?" Give them some examples by drawing some above-view pictures, some front-view pictures, and side-view pictures. Explain that a side-view sketch shows how something looks from the side, and that they will use their sketch as a blueprint. Show examples of the labeling that makes such sketches easy for someone to understand. To clarify the problem, show the students a launching "pad" location and have another student measure off five meters. The bean should fall somewhere within that distance.	Students deepen their understanding of a Design Brief and Black-box thinking	• Design brief • Sketch • Front-view • Side-view • Black-box model

Teacher Says/Does	Student Says/Does	Language requirements
8. Use a Black Box Model in handout **3.6.3** to further define the task: The teams should make several preliminary sketches, select one they like, then make a labeled sketch on an overhead transparency. Let the teams begin work on their bean launching models. Do not let anyone try to launch a bean until they show you a planning map and a side-view sketch for the device they have constructed. Remind them that safety is their job and ask them how they will be sure no one gets hit with their bean during testing.		

Day 3 Elaborate and Evaluate

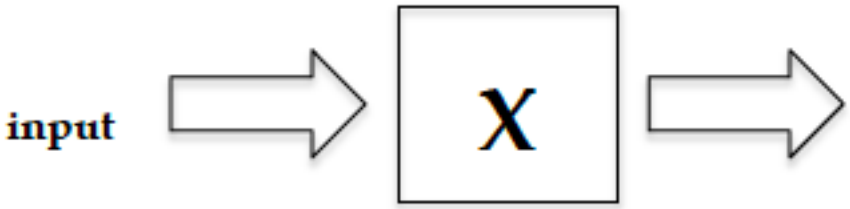
Teacher Says/Does	Practical Extensions	Language requirements
1. When teams are finished and have tested their models, have them present these materials, in turn: a. Their planning map b. The side-view sketch they drew as a blueprint c. The device they have constructed 2. Ask each team to demonstrate their device, and involve the rest of the class in evaluation: a. Was the planning map used well? b. Did the team seem to follow their blueprint? c. Does the device meet specifications and send a bean at least five meters away from the launch pad? 3. Each team reports: a. Where is the input work on the device? b. How many different pivot points did they try? What happened? c. Why did they choose the materials that you used? What properties of some of the materials were especially useful for the task? d. Where is the output work? e. How does a Black Box Model help think about the task? The rest of the class should ask the sharing team questions. f. Place the launching devices in the Design Gallery, along with the side-view sketches and each teams' written description of making the mechanism. Have the students place their planning map in the Design Portfolio.	Students share their planning and their bean-launching devices using Black-box thinking Students will brainstorm with parents real world examples of catapaults	Sketch Side-view sketch Planning map Black box model

Engage/explore

What you start with (input)	Things that happen in the middle (System of events)	What you end up with (Output)
2	(x 3) or (+2+2)	6

dog enters kitchen	cup tips over
1. dog sees cat 2. dog runs toward cat 3. cat jumps up on counter 4. cat bumps into cup of water cup tips over	
	a cat runs up a tree

A mysterious man adds a record to the jukebox in the doughnut shop.	1. Homer hears the tune. 2. Homer sings the tune to a friend 3. His friend sings it to another friend. 4. The whole town hears the catchy tune.
Everyone in town starts singing the tune and can't stop.	2
6	(x 3) or (+2+2)



Bean goes into the device.

Bean lands at least 5m away.

Design a device that will send a bean across a distance of at least 5 meters from where it starts.

Unit 7 (Mechanisms):
Linear and Back and Forth Motion

Concept Mechanisms can change size and direction of motion; linear motion is movement in a line; back-and-forth linear motion is called reciprocating motion. Up-and-down motion about a pivot point is an arcing or oscillating motion.

Content Objective Teams explore linear and reciprocating motion with linkages and slider mechanisms.

Language Objectives Students will recognize the meaning of the terms: linear, rotary and reciprocating, for types of movement
Students will write sentences using the words: linear, rotary, or reciprocating to describe types of movement
Students will deepen their knowledge of the meaning of: power, systems, input, lever and mechanisms

Standards

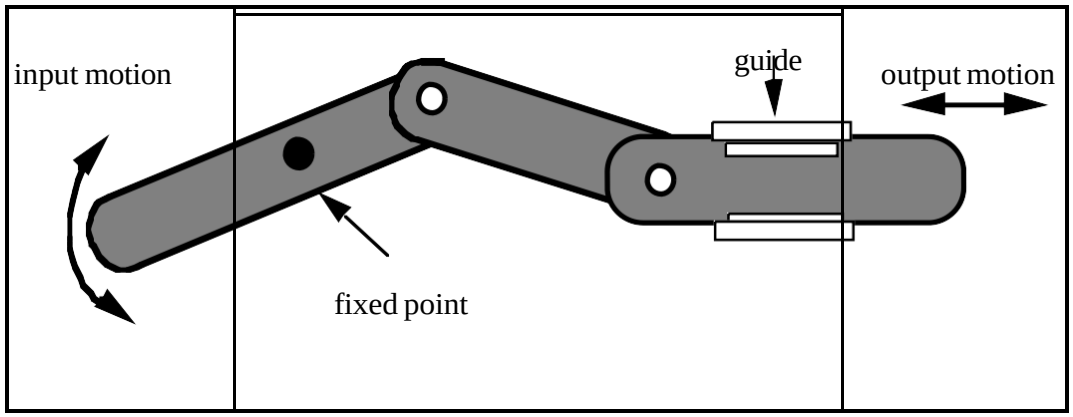
- **NGSS**
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool.
  - **K-2-ETS1-2.** Make a drawing or physical model to illustrate how the shape of an object helps it to solve a problem.
  - **K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses.

- **TEKS**
  - **2A** Plan and implement descriptive investigations, including asking and answering questions, making inferences, and selecting and using equipment or technology needed, to solve a specific problem in the natural world.
  - **2F** Communicate valid conclusions supported by data in writing, by drawing pictures, and through verbal discussion.
  - **3A** Analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing.
  - **3C** Represent the natural world using models and identify their limitations, including size, properties, and materials.
  - **6B** Demonstrate and observe how position and motion can be changed by pushing and pulling objects to show work being done such as swings, balls, pulleys, and wagons.

- **ELPS**
  - **1C** Use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary. [Metacognitive Strategies]

- **2E** Use visual, contextual, and linguistic support to enhance and confirm understanding of increasingly complex and elaborated spoken language [Context Clues]
- **3E** Share information in cooperative learning interactions [Communicative Competence]

Tools
Materials
Poster board strips; hole punch; paper fasteners; scissors; construction paper; glue guns; glue sticks; design brief on chart; lever model (Model of slider-crank Mechanism Figure 12).



Handouts **3.7.1-3.7.6**

Literature Conncetions
Motion: Push and Pull, Fast and Slow by Darlene R. Stille
Oscar and the Cricket: A Book about Moving and Rolling by Geoff Waring
Learning about the Way Things Move by Heidi Gold-Dwarkin

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Ask students what they think movement is, and to share their ideas. 2. Explain to students that we will be exploring movement in several directions. Tell them that we will be looking at objects and machines that can move up and down, on a straight line, around a circle, and also in a repetitive way either up and down or back and forth. 3. Describe simple everyday actions that involve linear, rotary and/or back and forth movement, e.g., brushing one's teeth (reciprocating motion). Have students share if they wish other examples. 4. Show students the picture cards in handout **3.7.1** with several examples of movement. Discuss with students one or two in terms of the type of movement. Then, give each pair or group an additional picture card from the handouts to discuss and identify if the movement is on a straight line, back and forth, repetitive back-and-forth or repetitive up-and-down. 5. Present word cards: *linear, rotary, reciprocating.* (see p.21 in Teacher Handbook for more clarification). Have the students say the word. Tell them that the movement that they worked with that was on a straight line can be called "linear"; that the movement that goes around the circle can be called "rotary" and the movement that goes in a repetitive way either up and down or back and forth can be called "reciprocating". 6. Distribute the handout **3.7.2** with descriptions of movement to each student pair and have them identify and write the type of movement it involves and have student pairs use the words: linear, rotary, or reciprocating in sentences. 7. Have students form groups and choose one of the activities in the following exploratory centers:	Students share their ideas about movement Students discuss different types of movement Students identify and write about linear, rotary, and reciprocating types of movements	• linear movement • rotary movement • reciprocating movement

Teacher Says/Does	Student Says/Does	Language requirements
○ Cut apart and mix up words, definitions and examples from **3.7.3**. Match them back up and glue to construction paper. ○ Look through books and note pages on which linear, rotary or back and forth motions are shown. ○ Illustrate a scene showing action of a person or object and draw arrows to show the direction of movement (*linear, rotary, back and forth*).		

Day 2: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Review with students the concepts of: *power, systems, input, lever and mechanisms*. Group students evenly into the five concept teams. 2. Use a Jigsaw procedure (**3.7.4**); have each team collaborate to construct drawings and sentences for their concept in relation to movement (*power, systems, input, lever or mechanisms*). Prompt students to complete the jigsaw handout before they leave their homogenous groupings. 3. Regroup into teams, each of which has one representative from each of the five concept areas. Have groups share with one another, guided by their jigsaw handouts. 4. Briefly review as a whole class the five concepts. 5. Read and discuss the following sentence with the whole class: Mechanisms can send energy through a system and increase it; mechanisms can also change the direction of input energy. 6. Have each group work on drawing the meaning of the sentence and sharing it with the class	Students investigate concepts of power, systems, input, lever and mechanisms Students read and discuss a paragraph about mechanisms	***Brick words:*** power • systems • input • lever • mechanisms

Day 3: Explore/ Explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Show the students the hidden lever model in a folder that you made to match the example in the Hidden Figure Handout **3.7.5**. When your input work was to push down the lever the other end went up. Show them a Black Box Model of the lever in the handout.		Black Box model Input Output
2. Ask the students if they can imagine what kind of system might produce a Black Box Model like this: INPUT → □ → OUTPUT Push down on one end → Other end goes back and forth	Students discuss options for a system that uses Black Box model thinking Students discuss Back and Forth motion and reciprocating motion	Back and Forth Motion Reciprocating motion
3. Students discuss as a group the kinds of things that could happen in a system in order for the output work to be back-and-forth motion. Tell them that this is called "reciprocating motion."		
4. Have student pairs use the handout **3.7.5** to look for examples of reciprocating motion around the school and playground.		
5. Have student pairs discuss/present their examples with the rest of the class.		

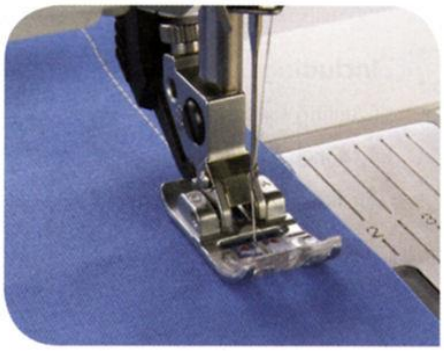
Day 4: Explore/ Explain

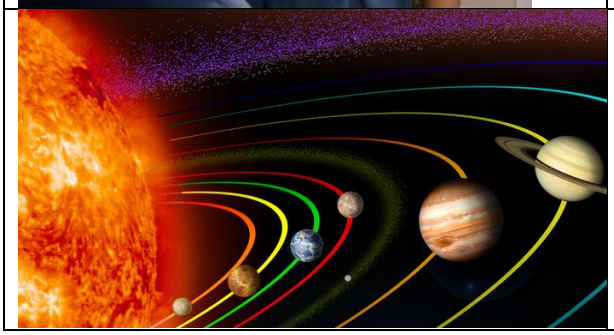
Teacher Says/Does	Student Says/Does	Language requirements
1. Show students your model of a slider-crank mechanism (Figure 12). Ask students to provide a definition of a lever, and to give examples of levers they are familiar with. Explain that levers in a series are called linkages, and that the last link, the one that goes back-and- forth, is called a slider. 2. Give students a picture of a model with a slider and linkages. Have them label the sliders and the linkages. 3. When the lever at one end of the folder is pushed down, the slider is made to travel back and forth. 4. Complete handout **3.7.6** to include a definition and illustration of each. 5. Go on a walk to find examples of sliders and slider-cranks. Many kinds of bolts are sliders, especially those found on bathroom stall doors and other enclosures. Many doors and windows have slider-cranks and linkages.	Students label parts of a model that has sliders and linkages	sliders slider-cranks levers linkages

Day 5: Explore/ Explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Remind them of how to work on a Design Brief: a. Look at the Black Box (***from Day 3***) as their Design Brief. b. Ask questions about what the words mean. c. When you understand what the words in the Design Brief mean, talk with your partner and plan what you might like to make. d. Make a plan for what you will make. Talk about who will do what jobs, and how you will make sure both people have interesting jobs to do. e. Draw a side-view sketch of what you will do.	Students explore different types of mechanisms	
2. Give the teams time to use trial-and-error to work with different types of mechanisms. They will find that a series of links connected together may create the input and output they want, but they will need to make some kind of guide for the slider so that it will be forced to go back and forth. Work with some teams to trouble- shoot during the process, and if several get frustrated, call the group back together to analyze what is being done in other groups that are having some success.	Students evaluate their design briefs	
3. When the teams have a completed folder to show, let them demonstrate it for the whole class, asking everyone to evaluate whether the product meets the Design Brief specifications. Ask the teams: o What was the hardest thing about your Design Brief? o Did you stick to your original plan? If not, why? o What were some skills you and your partner used while you worked together? o Where is linear motion demonstrated in your product? (One stroke of the lever, in one direction) Where is back-and-forth motion (reciprocating) motion shown?	Students, with parents, will identify linear	

Teacher Says/Does	Student Says/Does	Language requirements
○ How might the same folder show how linear motion can be transformed into rotational motion? (Push the slider back and forth and the link at the other side goes up and down in an arc.) 6. Also, ask the rest of the class what questions they have for the team that is presenting. 7. When each team has completed its presentation, let them display their folder in the Design Gallery along with their side-view sketches of the inside of their folder and a written explanation of how their product changed from their original plan, if it did		





Brushing your teeth	What kind of movement	Why?
A car going on a highway		
A child moving on a swing		
A child moving on a swing		
A sewing machine		
Planets moving around the sun		
Opening a door knob		
Clock handle moving		

Concepts about Motion:

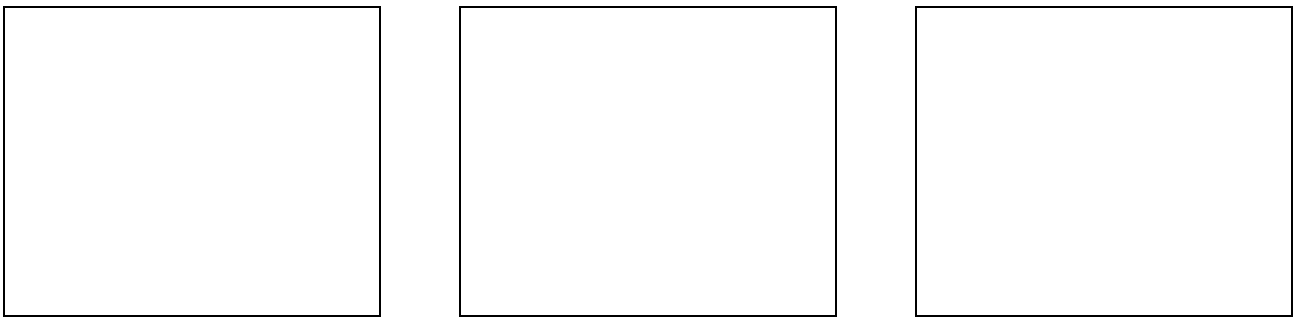
Type of motion	Definition	Example
Linear motion	Motion in one direction	Pushing a lever forward
Reciprocating motion	Linear motion that goes back and forth	Pushing and pulling a lever back and forth the piston in an engine moving up-and-down
Rotary motion	Motion in a circle	The hands of a clock moving, or a wheel on an axle
Oscillating motion	Circular or arc-motion back and forth	The swing of a pendulum or the turning and release of a doorknob

Jig Saw Activity

What is it?

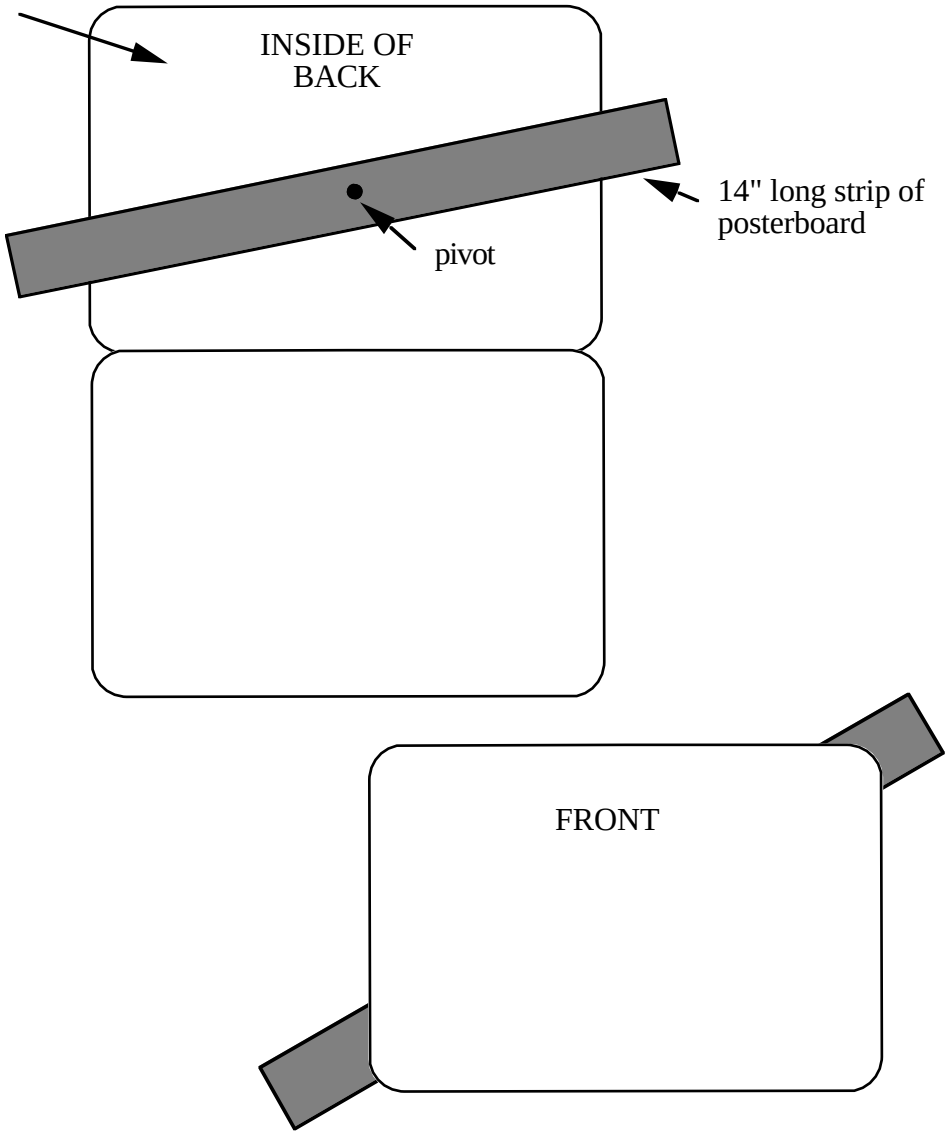
Description

Word



Examples

HIDDEN LEVER SYSTEM MODEL



Examples of reciprocating motion in the school		Describe the reciprocating motion
Example	Drawing	
Example	Drawing	Describe the reciprocating motion

Picture of a slider	Picture of a linkage
Picture of a lever	Picture of a slider-crank

Unit 8 (Work & Energy):
Power-Full Things

Concept Work can cause things to move; some systems can do more work than others; systems that can do the same work faster than other systems have more power.

Content Objectives Student teams identify and label examples of work.
Students differentiate systems that can do more work than others and systems that amplify input work.

Language Objectives Students discuss a labor-saving device using the word "power."
Students use the following words as part of oral discussions: "input", "mechanism", and "output."

Standards

- **NGSS**
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define problem that can be solved with a new or improved object or tool.
  - **K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses.

- **TEKS**
  - **3C** Represent the natural world using models and identify their limitations, including size, properties, and materials.
  - **3D** Connect grade-level appropriate science concepts with the history of science.
  - **6A** Explore different forms of energy, including mechanical, light, sound, and heat/thermal in everyday life.

- **ELPS**
  - **3D** Speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency [Application for Acquisition]
  - **2E** Use visual, contextual, and linguistic support to enhance and confirm understanding of increasingly complex and elaborated spoken language [Context Clues]
  - **3E** Share information in cooperative learning interactions [Communicative Competence]

Tools Materials	Bean-launching devices from last lesson
Literature Connections	*Tractors, Diggers and Dozers A Picture Book for Kids* by Lilley *Lights Construction Trucks What Would We do without Them?* by Maura Kempa *Katy and the Big Snow* by Virginia Lee Burton *Clevor Trevor* by Gregory Lay *B is for Bulldozer: A Construction ABC* by June Sobel

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Tell students that you will discuss how some systems or mechanisms have more power than others. Get students to share their ideas about the meaning of the word power. 2. Have student pairs discuss the different ways in which they have seen dirt being removed when it is in large quantities. Let them give their opinions of the differences of using: a backhoe or a bulldozer versus a person with a shovel 3. Have them use the word "powerful" in their answers by using the sentence frames in handout **3.8.1**. 4. Ask the students to describe the work accomplished by their bean-launching device and where energy went into the system and how it came out. If they didn't do a bean-launching device, show them a video of a labor-saving device, or use the sentence starters to discuss labor-saving devices at home and have them discuss them in terms of power. 5. Display the figure with **System 1 and System 2** from handout **3.8.2**. Ask student pairs to discuss whether system 1 or system 2 is more powerful, and to think of reasons 6. Have pairs share their answers and discuss how system 2 is more powerful because the ball travels faster.	Students discuss mechanisms with power Students compare systems in terms of their power	Power backhoe/bulldozer The _____is more powerful than the_____because _____

Day 2: Explore/ Explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Make large labels using the information in the Explore/explain section in handout **3.8.3**. Place the three labels in separate parts of the classroom. 2. Give each student one card **3.8.4**. It should be either an input, a mechanism, or an output. Ask students to raise their hands if they are an input, then if they are a mechanism, then if they are an output. 3. Then, have students move to their corresponding location in the classroom, labeled: "input", "mechanism", or "output" . 4. Have students who are "inputs" talk about what the other two components that goes with them: the mechanism, and the output. 5. Have students keep their labels and use them to form groups made up of three students: one input, one mechanism and one output. Have each group think of other examples of input, mechanisms and output from their home or school experiences. Or use the six cards provided for students to categorize. Have them write down the information on the table provided in handout **3.8.5**. If appropriate, once all groups are done, discuss the following questions as a whole group: • What system uses a microphone/amplifier/megaphone as a mechanism? • What mechanism can change small amounts of movement to larger amounts of movement? • What does a lever do? • How can we define mechanisms?	Students share their understanding of the concepts of: input, mechanism, output	Input Mechanism Output Lever Mechanism Mechanical advantage

Teacher Says/Does	Student Says/Does	Language requirements
6. Tell students you will read a paragraph, and they have to guess whether the missing word is increase or input: 7. Mechanisms let us _____the power of _____ work, so we can do tasks that would ordinarily be difficult. 8. Tell them that the relationship between the amount of input work and output work in a system is called “mechanical advantage,” and this tells us how powerful a machine-system is. 9. Have them share examples of mechanical advantage		

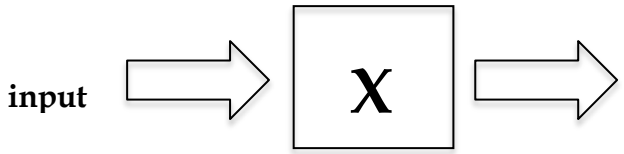
Day 3: Explore/ Explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Ask student teams to prepare a short enactment of a powerful machine at work. They should be ready to demonstrate it to the class and let the class members name the input and output work. For example, they may act out a forklift, with one student rolling as the wheels and another extending an arm to lift a heavy load. The input work is operating the machine with a wheel or switch, and the output is lifting a heavy load. 2. Allow the teams time to demonstrate their powerful machine skits and let the others guess what they are and where the input and output work is. 3. Students to draw pictures of people or machines working and display them on the bulletin board titled "Real Work We Do."	Students enact power Students draw pictures of people or machines doing work	

The _____is more powerful than the _____because _____ _____

One labor-saving device I saw in the video about the pyramids was_____
One labor device we have today is _____
A device in my house that saves labor is _____
It saves labor because_____ _____

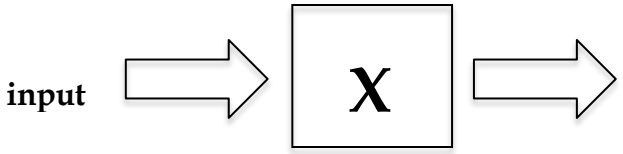
SYSTEM 1:



Ball is thrown

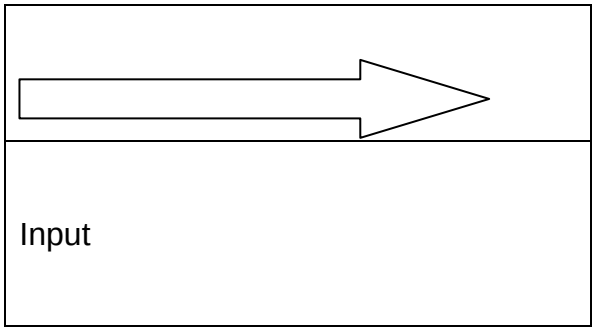
The ball flies 100 feet in ten seconds.

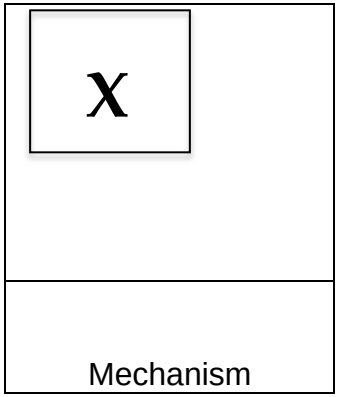
SYSTEM 2:

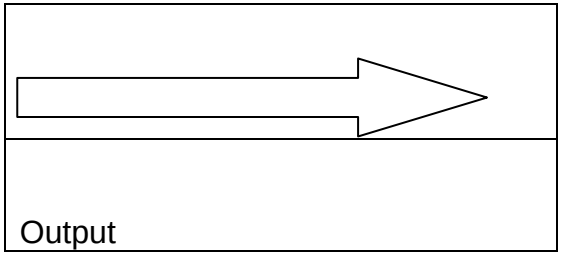


Ball is thrown

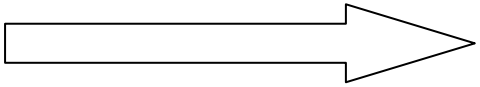
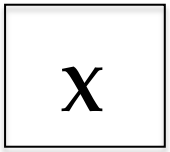
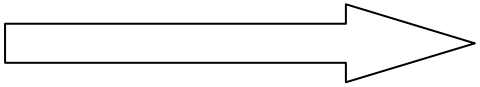
The ball flies 100 feet in five seconds.


Input


X
Mechanism


Output

Quiet sound	Megaphone	Loud noise
Bean goes in	A bean-launching device	Bean lands 5m away

		
Input	Mechanism	Output

Unit 9 (Systems):
If-Then Logic

Concept We can analyze a chain of action.

Content Objective Students will create models that demonstrate a chain of 3 connected events.

Language Objectives Students will use if/then statements to describe basic features of a chain of events

Standards

- **NGSS**
  - **3-PS2-1.** Plan and investigate the effects of balanced and unbalanced forces on the motion of an object.
- **TEKS**
  - **1A** Demonstrates safe practices during classroom investigations.
  - **2A** Plan and implement descriptive investigations, including asking and answering questions, making inferences, and selecting and using equipment or technology needed, to solve a specific problem in the natural world.
  - **3A** Analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing.
  - **4A** Collect, record, and analyze information using tools.
  - **4B** Use safety equipment as appropriate, including safety goggles and gloves.

- **ELPS**
  - **4G** Demonstrate comprehension of increasingly complex English by participating in shared reading, retelling or summarizing material, responding to questions, and taking notes commensurate with content area and grade level needs.
  - **5B** Write using newly acquired basic vocabulary and content-based grade-level vocabulary.
  - **3D** Speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency [Application for Acquisition]

Tools	Models of the folders on **p. 24-28 in Teacher Handbook**
Materials	Posterboard, paper fasteners, tape, scissors, strips of cardboard or tongue depressors, glue, straws, toothpicks, index cards, stapler Handouts **3.9.1-3.9.4**
Literature Connections	any of the *There Was an Old Woman*…books and any of the *If You Give a Mouse a*… books

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Read with your class the folk song (or poem) in handout **3.9.1**, "There was an old woman who swallowed a fly…" 2. Ask the students to help you list the events that occurred, using the graphic organizer in handout **3.9.2**. 3. Display the folk song so all students can see it, and then have a discussion with students identifying what events in the chain could have been omitted without affecting the end result. 4. Discuss what the old woman must have been thinking by referring to the following phrases: a. "If I swallow a spider, then it will catch the fly. b. If I swallow a bird, then it will catch the spider…" and so on 5. Have them consider if the old woman would have swallowed a. a dog if she hadn't swallowed a fly. 6. Tell the children that a chain of events in a story is similar to the chain of events in the poem just discussed and also in a moving machine or in a computer. 7. Ask students to work in pairs and create a chain of events using the graphic organizer in handout **3.9.3**, or fill in the one that has a starting event and a final event. 8. Encourage them to reflect on their chain of events and use the sentence starters in handout **3.9.4** to write down ideas about their work.	Students use a folk song to get familiarized with the concept of a chain of events	• chain of events

Day 2: Explore/ Explain

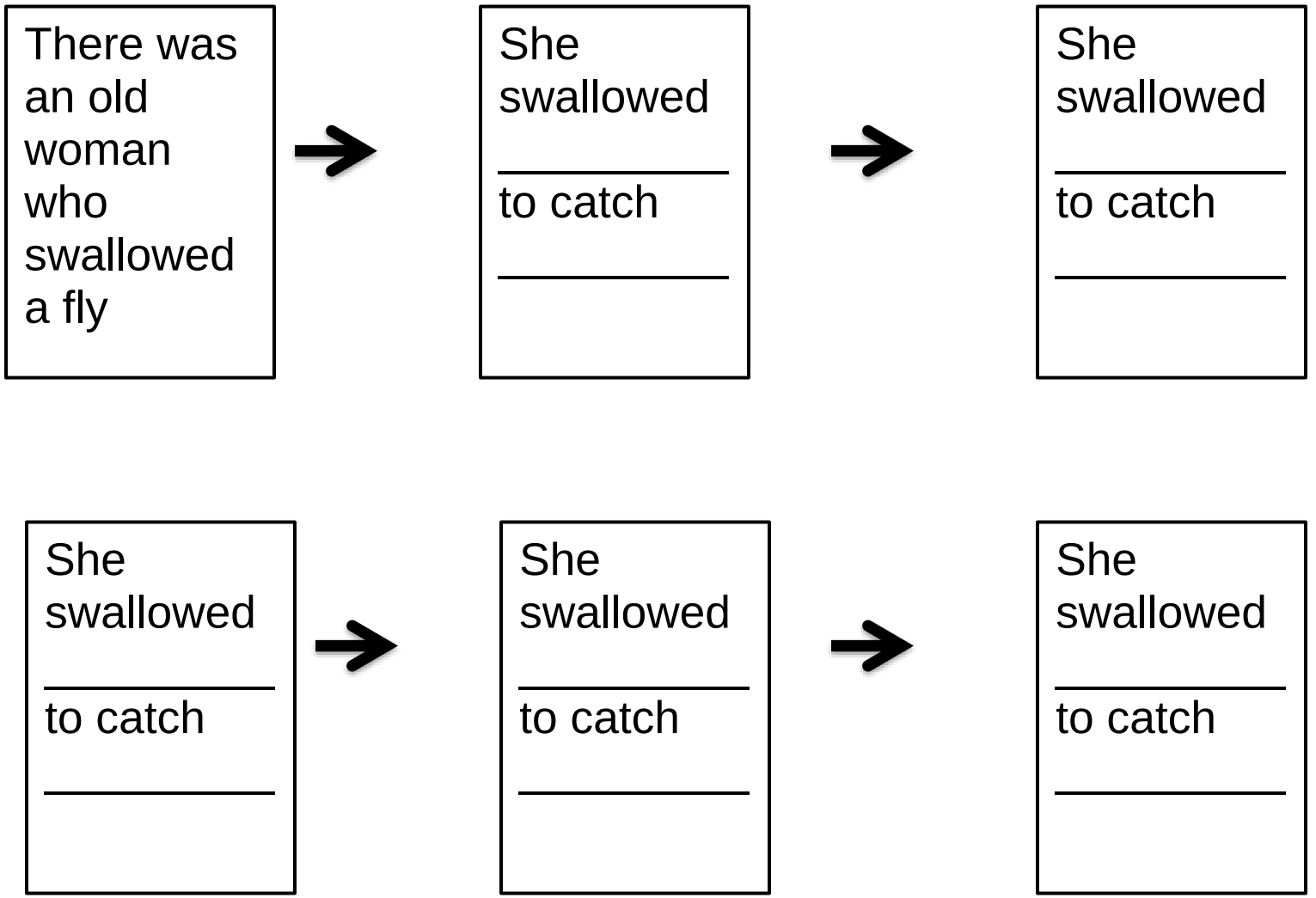
Teacher Says/Does	Student Says/Does	Language requirements
1. Tell the children that today they will make a puzzle with a chain of events that only their team knows about and quiz the class on it. Discuss how a chain of events in a story is similar to the chain of events in a moving machine or in a computer. 2. Review chains of events that students have constructed, or discuss with the class the following example: • If your brother drinks the last of the milk tonight, there won't be milk for breakfast. • If there is no milk for breakfast, you will have to eat breakfast at school. • If you have to eat breakfast at school, you will need to get up earlier than usual. • If you will need to get up earlier than usual, you'd better reset your alarm clock. 3. Ask: How did your brother drinking milk make you re-set your alarm clock? 4. Ask the teams to think of a chain of events, real or fictional, and write (or draw) the first event (cause) and final event (effect) on the sides of the folder where everyone can see them. Then they write (or draw) the other events in the chain inside the folder. • Note: Some students may need to consider "short" event chains first; have them create several folders, getting more complex each time as possible.	Students compare the chain of events in a story with the chain of events in a moving machine or a computer Students create a chain of events	Chain of events

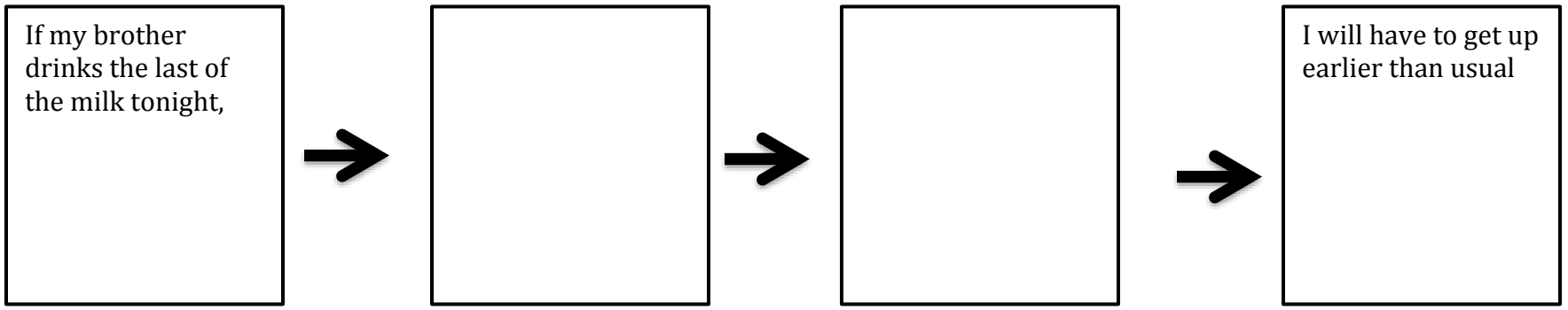
Day 3: Elaborate and Evaluate

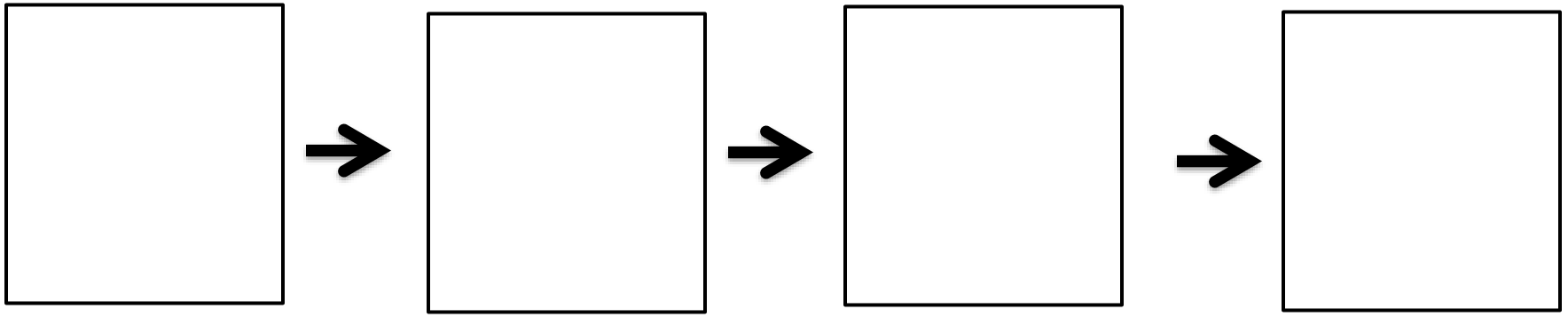
Extensions into the disciplines	Practical Extensions	Language requirements
1. When teams are finished, they should present their puzzle folders to the class. When they do so, they should ask their classmates to guess what happens inside the folder! 2. Ask the students: a. If you could do some "fixing," or "trouble-shooting" in your story chain of events, what might you fix to make the end result different? b. How does understanding the chain of events in a system help trouble-shoot when there are problems? 3. Place the folders in a Design Gallery with titles, or accompany them with a paper chain in which each link has one story event that causes the next.		

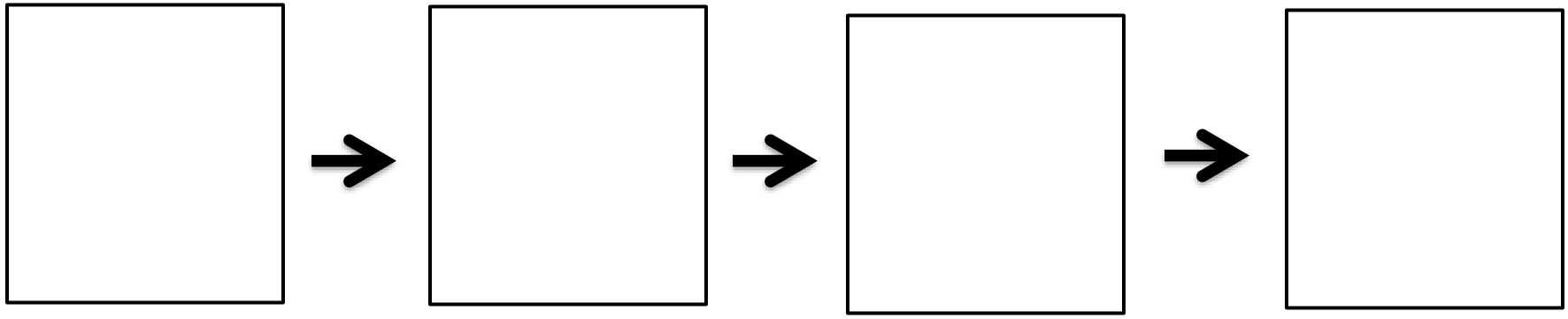
There was an old woman who swallowed a fly, I don't know why she swallowed a fly, I guess she'll die; There was an old woman who swallowed a spider that wriggled and jiggled and tickled inside her; she swallowed the spider to catch the fly, but I don't know why she swallowed the fly, I guess she'll die; There was an old woman who swallowed a bird, how absurd! She swallowed a bird! She swallowed the bird to catch the spider that wriggled and jiggled and tickled inside her; she swallowed the spider to catch the fly, but I don't know why she swallowed the fly. I guess she'll die. There was an old woman who swallowed a cat.

Imagine that! She swallowed a cat! She swallowed the cat to catch the bird, she swallowed the bird to catch the spider that wriggled and jiggled and tickled inside her; she swallowed the spider to catch the fly, but I don't know why she swallowed the fly. I guess she'll die. There was an old woman who swallowed a dog. She went the whole hog! She swallowed a dog! She swallowed the dog to catch the cat, she swallowed the cat to catch the bird, she swallowed the bird to catch the spider that wriggled and jiggled and tickled inside her; she swallowed the spider to catch the fly, but I don't know why she swallowed the fly. I guess she'll die. There was an old woman who swallowed a cow. I don't know how she swallowed a cow! She swallowed the cow to catch the dog, she swallowed the dog to catch the cat, she swallowed the cat to catch the bird, she swallowed the bird to catch the spider that wriggled and jiggled and tickled inside her; she swallowed the spider to catch the fly, but I don't know why she swallowed the fly. I guess she'll die. There was an old woman who swallowed a horse. She died, of course.


There was an old woman who swallowed a fly
She swallowed _____ to catch _____
She swallowed _____ to catch _____
She swallowed _____ to catch _____
She swallowed _____ to catch _____
She swallowed _____ to catch _____


If my brother drinks the last of the milk tonight,
I will have to get up earlier than usual





Our chain of events was about _____
We chose it because _____
The first event was_____
The last event was_____