Design Technology in Engineering Education for English Learners: Project DTEEL

NSF DRK-12 #1503428

University of Texas, Austin

Grade Kindergarten
Lesson Plans
Units 1-9

DTEEL Kindergarten Lessons

Unit 1 (Materials):
Our Material World

Concept
There are many different materials around us.

Content Objective
Explore school to collect, observe and analyze materials.

Language Objectives
Students will learn new vocabulary regarding materials (e.g., wood, glass, plastic) and their characteristics (e.g., rough, smooth, cold, hard).
Students will use materials vocabulary to name and describe the materials in their school surroundings to their partners.
Students will orally share ideas using sensory vocabulary specific to materials and their characteristics.
Students will use invented spelling to cooperatively sound out and use at least one characteristic for each sensory category, describing one or more materials.

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.
- **TEKS:**
  - **2C** collect data and make observations using simple equipment such as hand lenses, primary balances, and non-standard measurement tools (collect data with tools)
  - **2D** record and organize data and observations using pictures, numbers, and words (organize data)
  - **4A** collect information using tools, including computers, hand lenses, primary balances, cups, bowls, magnets, collecting nets, and notebooks; timing devices, including clocks and timers; non-standard measuring items such as paper clips and clothespins; weather instruments such as demonstration thermometers and wind socks; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
  - **5A** observe and record properties of objects, including relative size and mass, such as bigger or smaller and heavier or lighter, shape, color, and texture (prop of objects)
- **ELPS:**
  - **Listening 2C:** Learn new language structures, expressions, and basic and academic vocabulary heard during classroom instruction and interactions [auditory syntax & lexicon]

- **Speaking 3B:** Expand and internalize initial English vocabulary [Oral Lexical Development]
- **Writing 5B:** Write using newly acquired basic vocabulary and content-based grade-level vocabulary

Suggested Literature Connections:
"Beautiful Oops!" by Barney Saltzberg

Materials:
To show: wooden, glass, china, plastic, aluminum, and paper plates or spoons
To dissect: (Collect as many as possible) Brick, cinder block, T-shirt, grass, steel nail, old sneaker shoe, pencil, paper clip, cookie, old glue stick, cereal box, foil, etc.
To use: Wooden popsicle sticks, hand lenses

Suggested Activity Centers
- **Sorting:** Students sort and organize materials into categories
- **Collage:** Students identify and cut pictures from magazines and catalogs of items made of wood, plastic, glass and metal.
- **Reading/Listening:** Provide books and tapes about what things are made of.
- **Art:** Paint a picture of a wooden car, or a glass house.
- **Cooking:** Sort kitchen tools and equipment into materials; sort other housekeeping equipment into materials.

Day 1: Engage/Explore *Materials: Our Material World*

Teacher Says/Does	Student Says/Does	Language requirements
1. *Preparation:* Make sure that students can name and have experience with different materials like wood, paper, plastic, etc. 2. *Whole Group:* Hold one set of different objects such as those on the list and ask the students what they think the things are made of and where they came from. 3. Explain that we use the word, "MATERIALS" to mean the stuff of which objects are made. 4. Share different materials, identifying their characteristics with students. • E.g. Hold up a plate, asking the children to tell how they use materials like that at home. E.g. for cooking or eating. Ask children about the characteristics of the material and have them share orally with a partner. *What color is it? What is the texture? How does it feel? Is it bendable/breakable?* Let the students feel each object, and talk about things children see around them that look like the materials in each object. • E.g. Hold up a piece of cloth, such as from your clothing. Ask the children if they see plates or spoons made of that material. *Why don't we make plates of cloth?* Hold up a rubber band or ball. *Do we make plates of rubber? Why or why not?* Key concept: Plates or objects you have shown them are made of materials we see everyday. Brainstorm a list of other materials on chart paper that can be added to throughout the module.	Students talk with partners about the characteristics of the materials. After 30 seconds-1 minute, some students share their ideas in the whole group.	Vocabulary: materials

Teacher Says/Does	Student Says/Does	Language requirements
5. Give each student a popsicle stick and go on a walk around the inside and outside of the school. Ask students to find out how materials sound when tapped by the popsicle stick, and how materials feel and smell. Model the use of the sentence frame. Collect some pieces of interesting material to analyze. 6. While exploring, collect students' words, ideas to add at end. 7. Complete Graphic Organizer Web (handout (**K.1.1)** as a class brainstorming the materials students observed on the walk.	Students touch and talk about the surfaces and materials they see during the walk.	Sentence frame: I'm going to tap, tap, tap, feel, feel, feel, hear, hear, hear _____.

Day 2: Explain/Elaborate *Materials: Our Material World*

Teacher Says/Does	Student Says/Does	Language requirements
1. *Review the Web:* Hand out extra cutouts from the Collage Center (one of the Activity Centers). Model the process of adding them to the web handout (**K.1.1**). *Treasure Hunt:* Explain that the students will go on a treasure hunt for different materials around the classroom (or school/playground). Review your expectations for safe and respectful conduct. In pairs, students either draw or record their observed materials (e.g. pebble, railing, door, doorstop) using "Materials Graphic Organizer" handout (**K.1.2**).	Individual students match their cutouts to words/images on web. Students in pairs will hunt for different materials around the classroom: [find: plastic, wood, metal, paper, glass, fabric, rubber].	Vocabulary: *plastic, wood, metal, paper, glass, fabric, rubber.*
2. *(Guided) Partner Presentations:* When the students have returned from the treasure hunt, explain that they will present a material. Model the process using a sentence frame with specific vocabulary words.	Each student pair presents one found or identified material.	
3. While the student pairs present, pose questions like: *What is the material called? Where did you find it? What is it made of?* Teachers will also want to think with students about how to categorize objects made of multiple materials.	Students in the audience can ask also questions of the presenting group.	We found a _____, and it is made of the material _____.

Day 3: Evaluate *Materials: Our Material World*

Teacher Says/Does	Student Says/Does	Language requirements
1. Read aloud the book, *My Senses*: how do things feel, look, smell, sound.		
2. Present tools for exploration: "Scientists use tools (e.g. hand lenses and popsicle sticks) to gather data describing the characteristics of materials."	Students talk about an example of the sense in question.	
3. Model exploration of one material: (See Senses Graphic Organizer handout (**K.1.3**)—talk through each sense and the characteristics you observe using each sense—less taste) • Incorporate one pair share after each sense—e.g. turn to your neighbor and "feel" a material around you (touch the cloth on your pants). *How does it feel/smell/look/sound?*	Students explore different materials, paying attention to the material properties using their various senses.	
4. *Table Groups:* Divide the class into groups and give each group a basket of 3-5 materials. How can we describe the material? Teacher may facilitate group discussion by asking prompting questions, e.g., How does ____sound when you tap it with the stick? How does it feel under your finger?	Student groups analyze the material using their senses and tools.	
5. Explain that each group will present one material. Ask questions like: How does it feel/look/sound/smell? Record the students' observations on the class anchor chart (**Figure 1** below).	Each group presents one material they studied. They highlight the material properties according to their senses.	

Figure 1 *Materials: Our Material World*

Type of Material	Characteristics of Material			
	Looks like 	Sounds like 	Smells like 	Feels like 

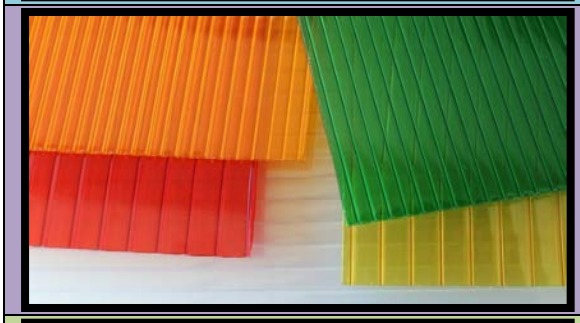
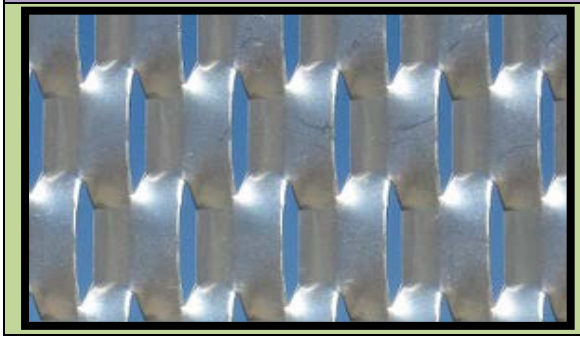
Name: _____ Date: _____

Graphic Organizer Walk Web:

Write down the materials you saw on the walk.

Names: _____ Date: _____

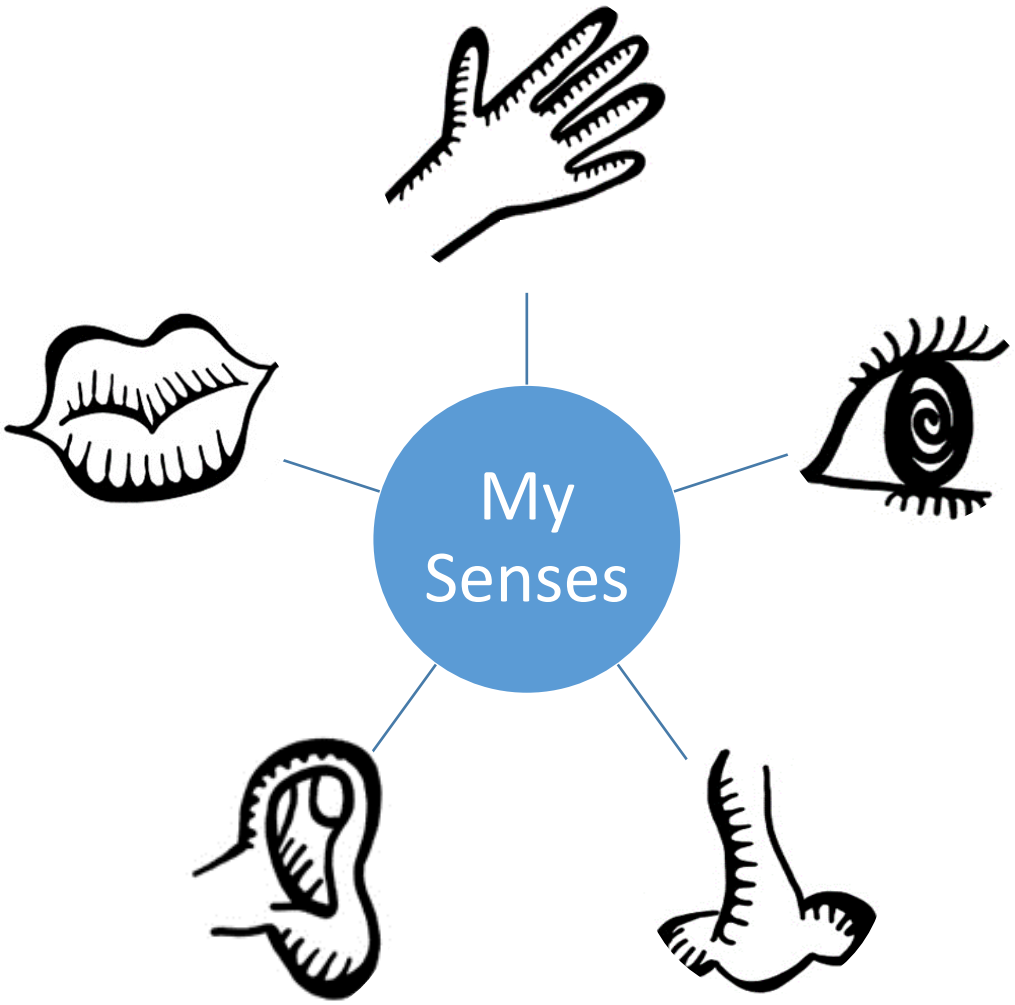
Materials Graphic Organizer:

Type of Material	Properties
Glass Wood Plastic Metal Concrete Paper	Breaks Strong Pings Bends Flexible Elastic (Stretches)
	
	
	
	

Type of Material	Properties
Glass Wood Plastic Metal Concrete Paper	Breaks Strong Pings Bends Flexible Elastic (Stretches)
	
	

Name: _____ Date: _____

My Senses Graphic Organizer



Unit 2 (Materials):
Properties of Material-- Elasticity

Concept
Some materials bend and some do not.

Content Objective
Students test and sort objects that bend.

Language Objectives
Students will access prior knowledge by discussing with a partner about different kinds of materials, their characteristics, and their uses.
Students will draw conclusions about the properties of materials using high-frequency and subject-specific vocabulary.
Students will draw objects and their corresponding symbols related to elasticity in order to compare and contrast the different levels of elasticity between different objects.
Students will use high-frequency English words necessary for describing their objects to the class such as: *bends, breaks, elastic, flexible, property, wood, metal*, and *plastic*.

Standards
- **NGSS:**
  - **K-PS2-1.** Conduct investigation comparing strengths and directions of pushes and pulls on motion of object.
- **TEKS:**
  - **2B** plan and conduct simple descriptive investigations such as ways objects move (investigate movement)
  - **2C** collect data and make observations using simple equipment such as hand lenses, primary balances, and non-standard measurement tools (collect data with tools)
  - **2D** record and organize data and observations using pictures, numbers, and words (organize data)
  - **5A** observe and record properties of objects, including relative size and mass, such as bigger or smaller and heavier or lighter, shape, color, and texture (prop of objects)
- **ELPS:**
  - **LLS 1A:** Use prior knowledge and experiences to understand meanings in English
  - **LLS 1C:** Use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary.
  - **Speaking 3B:** Expand and internalize initial English vocabulary [Oral Lexical Development]

Suggested Literature Connections:
"The Three Little Pigs"

Materials:
Samples of materials from last lesson (eg., wooden, glass, china, plastic, aluminum, and paper plates or spoons, cinder block, T-shirt, grass, steel nail, old sneaker shoe, pencil, paper clip, cookie, old glue stick, cereal box, foil, wooden popsicle sticks, hand lenses)

Suggested Activity Centers

- **Sorting:** Students sort various materials into bendable/not bendable categories and make up their own, in-between categories.
- **Collage:** Students cut out pictures from magazines and catalogs of items that bend.

Day 1: Engage/Explore/Explain *Materials: Elasticity*

Teacher Says/Does	Student Says/Does	Language requirements
1. Connect to students' prior knowledge by showing them some of the objects that they analyzed during the previous module. 2. Ask students to recall in pairs what they learned about materials during previous activities, e.g. *Which materials do we find in the classroom or on the playground? How does that material feel, look, sound, or smell?* Ask students what they may have noticed about materials in the world outside the school, e.g. *Did they see any objects made of wood at home? Any objects made of plastic? How did it feel, look, sound, or smell? Which objects appeared to be comprised of two or more materials?* 3. Introduce key vocabulary. Start by explaining that we use the word, "FORCE" to mean pushing and pulling things. Provide a visual, e.g. use the "Visuals for Forces and Elasticity" handout (**K.2.1**). One-minute optional video about force: https://www.youtube.com/watch?v=AC0fgExu0A4 4. Explain that we use the word, "PROPERTIES" to mean something that we can observe with our senses about a material/object. Provide a visual, e.g. use the "Visuals for Forces and Elasticity" handout (**K.2.1**). 5. Model properties experiment (one object): Ask students to make predictions in pairs about the object's properties of strength and flexibility when force is used on it, e.g. *If you hold either end of the object and pull in opposite directions, what will happen? (It may stretch.) If you try to flex the object, what will happen? (It may bend.)* Ask a student to	Students talk with their partners and then share responses with the whole group. Students watch video. They can perform hand motions to mimic pushing and pulling forces. Student pairs predict how strong and/or flexible an object will be.	Vocabulary: *force, properties, elasticity, bends, breaks, elastic, flexible, property, wood, metal,* and *plastic* I predict that _____ will _____ because _____.

Teacher Says/Does	Student Says/Does	Language requirements
come up and apply force to the object after predictions are shared. Hold up a second object that is quite different from the first. Ask students to predict if it will have the same property of bending/flexibility as the first object.	Individual students push or pull as part of the whole group demonstration.	
6. *Partner Experiment*: Provide each pair of students with a few objects (e.g. play dough, pencil eraser, soft toy, building blocks), and send them to experiment at tables. Remind them to first share predictions about the properties of each object, and then to apply force by pushing and pulling on objects to discover properties of flexibility and strength.	Students work in pairs to predict and then test the flexibility and strength of each object.	When I pushed/pulled the _____, it _____.
7. *Guided questions during experiment: Which materials bend one way but won't bend back? Which materials stretch? Which materials don't change when you put a force on them? Which materials seem strong? Which seem weak?*		I predicted that _____.
8. *Whole Group*: Come together to share and complete a chart (similar to "Properties of Elasticity" handout **K.2.2**) of what students discovered about the property of elasticity with the different objects they experimented with. Using materials from Unit 1, explain that we use the word "ELASTICITY" to describe whether or not a material is bendable/flexible. You may also provide a visual, e.g. use the "Visuals for Forces and Elasticity" handout (**K.2.1**). Hold up some different objects that they experimented with and brainstorm as a class their observations about the elasticity of each object. When they applied force either through pushing or pulling, *did it bend, did it break, or was it inflexible*?	Students share their observations from the experiment.	When I applied force, _____ __.

Teacher Says/Does	Student Says/Does	Language requirements
For objects that are more complicated such as plastic that may bend and then break, put a question mark and tell students you will revisit these objects next lesson. Do they notice any patterns with elasticity and the type of material? *E.g. Objects made of rubber tend to bend.*		

Day 2: Elaborate/Evaluate *Materials: Elasticity*

Teacher Says/Does	Student Says/Does	Language requirements
1. *Review* concept of elasticity and "Properties of Elasticity" chart (similar to handout **K.2.2**) with students. Create a gesture together with students that matches the definition of elasticity, e.g. a rubber band/wavy arm. Have students chorally repeat the word elasticity and mirror the gesture back at you. This *elasticity gesture* can be used throughout these lessons as transition signals for active engagement and building academic vocabulary.	Students create and perform the gesture representing elasticity.	
2. *Turn & talk- whole group work.* Pair students up and have them look around the classroom with clipboards to find objects made of materials that do and do not bend. Using the "Properties of Elasticity" handout (**K.2.3**), have each pair draw a sketch of 2-3 objects that they found and draw the symbol that corresponds with each object's property of elasticity: An upside down U for flexible, a broken line for breaks, a straight line for inflexible, and a question mark symbolizing a complex property of elasticity that is difficult to categorize. See the graphic organizer in **Figure 2** below for guidance.	Student pairs record their observations of objects from around the room.	
3. *Come back together.* Ask each pair to share out an object that they found and its property of elasticity. Add to the chart created in Unit 1>Day 1. Invent some in-between categories for objects that may be difficult to categorize. For example, "*bends then breaks*," "*won't bend back*," etc.	Student pairs share their observations with the whole group.	We tested a _____. When we pulled / pushed / applied force, the _____.
4. *Discuss* the reasons for elasticity and flexibility in materials. Pose questions such as: *Why is it important for "x" material to bend/not bend?*	Students discuss their responses.	

Teacher Says/Does	Student Says/Does	Language requirements
5. *Connect* to other properties observed in earlier lessons. *What other properties besides elasticity did we observe about these materials in earlier lessons?* Write the students' words on the word chart for materials (See example in **Figure 3** below for guidance). 6. Teacher might help students create a graphic organizer that allows students to connect types of materials with different properties: e.g., *Which of these properties applies to each type of material?*	Students share their thoughts about elasticity, strength, and flexibility, etc.	

Figure 2 *Materials: Elasticity*

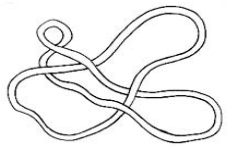
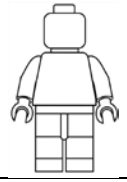
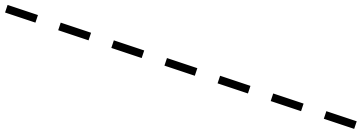
DRAW OBJECT/MATERIAL	PROPERTY OF ELASTICITY
	
	
	

Figure 3 *Materials: Elasticity*

Types of Materials	Properties
Glass	Breaks
Wood	Strong
Plastic	Pings
Metal	Bends Flexible Elastic (Stretches)

Name: _____ Date: _____

Visuals for Forces and Elasticity

Force

Properties

Elasticity

Properties of Elasticity (Example for Teacher Chart)

OBJECT/MATERIAL	PROPERTY OF ELASTICITY
E.g. Paperclip (metal)	 Bends
	 Breaks
	 Inflexible

Name: _____ Date: _____

Properties of Elasticity

DRAW OBJECT/MATERIAL	PROPERTY OF ELASTICITY

Unit 3 (Materials):
Making a Bendable Toy

Concept
Some materials can bend and can be changed or connected with tools.

Content Objective
Students work in teams of two or three on the first Design Brief.

Language Objective
Students will listen to the teacher orally explain the Design Brief task, and will orally share questions they have, first with partners and later with the class, in order to seek clarification.
Students will express their opinions about the other engineering pair's plans for the bendable toy, using such phrases as "I like that you use (blank)" OR "I love that your toy (blank)."
Students will describe their bendable toy to the class using increased specificity and detail depending upon their level of oral English language development.

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** identify and demonstrate safe practices as described in the Texas Safety Standards during classroom and outdoor investigations, including wearing safety goggles, washing hands, and using materials appropriately (identify)
  - **1B** discuss the importance of safe practices to keep self and others safe and healthy (discuss)
  - **2D** collect data and make observations using simple equipment such as hand lenses, primary balances, and non-standard measurement tools (organize data)
  - **3C** explore that scientists investigate different things in the natural world and use tools to help in their investigations (connect to adult scientists)
  - **4A** collect information using tools, including computers, hand lenses, primary balances, cups, bowls, magnets, collecting nets, and notebooks; timing devices, including clocks and timers; non-standard measuring items such

as paper clips and clothespins; weather instruments such as demonstration thermometers and wind socks; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
    - **5A** observe and record properties of objects, including relative size and mass, such as bigger or smaller and heavier or lighter, shape, color, and texture (prop of objects)
    - **6D** observe and describe the ways that objects can move such as in a straight line, zigzag, up and down, back and forth, round and round, and fast and slow (how objects move)
- **ELPS:**
    - **Listening 2D:** Monitor understanding of spoken language during classroom instruction and interactions and seek clarification as needed [Comprehensible Input]
    - **Speaking 3G:** Express opinions, ideas, and feelings ranging from communicating single words and short phrases to participating in extended discussions on a variety of social and grade-appropriate academic topics; [Speech Production @ Grade Level]

Suggested Literature Connections:
"Have You Thanked an Inventor Today?" by Patrice McLaurin

Materials
Tools & Connectors: hole punch; low temp glue gun; scissors; tape dispensers; brads; construction materials: poster board; cloth; wood; foil; paper; Safety First Buttons; recycled plastic items; aluminum cans; cereal boxes; milk cartons; newsprint; paper tower rolls

Design Brief
Make a toy that can bend and is made of at least 3 different materials.

Suggested Activity Centers
- **Labeling:** Label things around the room that bend.
- **Art:** Draw or paint a picture of a toy that can bend.
- **Collage:** Cut out pictures from magazines and catalogs of toys and things to play with.
- **Cooking:** Draw or cut out pictures of foods that can bend. Alternatively, make and eat fruit leather cut-outs of toys that can bend.

Day 1: Engage/Explore/Explain *Materials: Making a Bendable Toy*

Teacher Says/Does	Student Says/Does	Language requirements
1. Show example(s) of bendable toys prior to lesson (e.g., wooden pull puppets). *2. Review* the properties of flexibility and elasticity from Unit 2, Lessons 1 & 2, referring to graphic organizers from the activities. Ask students to *share with a partner* to recall what flexible/bendable means, what elastic or elasticity means, and what kinds of materials have these properties. Reintroduce the *elasticity gesture* from Unit 2 and use throughout these lessons for transition signals. 3. *Display and introduce* the Design Brief **Make a toy that can bend and is made of at least 3 different materials** Tell the students that this challenge gives them a job to do in a team of two engineers. *4.* Read the Design Brief to the students. Tell them there are steps to follow in responding to a Design Brief: Step 1. Ask questions to be sure you understand the Design Brief! Step 2. Make a plan before you work. Step 3. Remember safety rules. Step 4. Check what you make. *Note:* Include visuals next to each step, such as the ones in the "Bendable Toy Design Brief" handout (**K.3**), and display them so students can see them as they work.	Students discuss vocabulary from Unit 2 and perform elasticity gesture.	Review vocabulary: *elasticity, strength, flexibility*

Teacher Says/Does	Student Says/Does	Language requirements
5. *Model.* Show students an example of a bendable toy that you created using three different materials, ideally with two of the materials different from available materials to encourage student creativity. Display the sketch that you first made on paper to plan your bendable toy. Tell the students that they will work in a team to make a bendable toy, or toys, together. Present samples of different materials and tools that engineering teams will have at their disposal to create the bendable toys. 6. *Step 1 of Design Brief. Ask questions.* Have students sit with their engineering partners to brainstorm any questions that they have about the brief. Allow ample time for questions and check for understanding. 7. *Step 2 of Design Brief. Make a plan.* Look at the Design Brief again. Ask the students to close their eyes and imagine what a bendable toy might look like and to imagine a bendable toy they might have at home. Tell them that this "imagining" is an important step in planning, because it will help them think of good ideas. Ask students to *talk with their engineering partners* to discuss what materials they think their imaginary bendable toy or the toy at home might be made of to possess that property of elasticity. Reinforce that a plan is just a starting point and that plans sometimes need to be changed in the process. 8. *Pair work*: Send engineering teams to their tables with one paper and one pencil per pair to make a sketch of their plan for the bendable toy they will create. To encourage creativity and spread peer learning, teachers should emphasize that teams	Student pairs brainstorm questions. Students close their eyes and imagine bendable toys. In pairs, students discuss their ideas for the toy materials.	Could you explain _____? How does _____? I am not sure what _____ means.

Teacher Says/Does	Student Says/Does	Language requirements
should try to use different designs and materials from other teams. 9. Have *available materials* at each table, and one set of tools at the front of the room where all students can view them as they plan. Pose questions as they work such as: *How did you get this idea? Which three materials will you use? Which tools will be useful to change those materials? What will your toy look like? How will you make it bendable/flexible/elastic?* *Note:* You may consider creating a planning sheet for each engineering team with labeled pictures of each material available as well as labeled pictures of each tool available. Then, each team could circle the 3 materials and the tools they intend to use, and draw a picture of their imagined toy. This should be in addition to, not in place of, having the actual materials and tools there for students to look at as they plan. 10. *Engineering pairs share in quad.* Once all engineering pairs have their plans, have two pairs meet together to share their plans for bendable toys. You may decide to make this more structured by asking each person to give positive feedback to each pair about their plan. Encourage each pair to share suggestions for naming their bendable toy they have planned, and to choose a name.	Student pairs work together to sketch different plans for their bendable toys. Student groups of 4 share their plans, possibly using the sentence stems to structure their feedback.	Sentence stems: "I like that you use_____. " OR "I love that your toy_____."

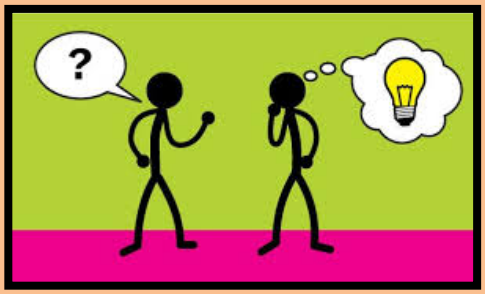
Day 2: Elaborate/Evaluate *Materials: Making a Bendable Toy*

Teacher Says/Does	Student Says/Does	Language requirements
1. *Review* the Design Brief with students. Briefly review Steps 1 and 2 of a Design Brief. 2. *Step 3 of Design Brief. Remember safety rules*. Ask students to orally share with their engineering partners why it is important to be safe when working with tools. You may decide to create a class list of safety rules when working with tools. Ask students to come up and model the correct way to hold/use each tool. You may have a student purposefully model the incorrect way to use a tool, and then model its correct use. 3. *Step 4 of Design Brief. Check what you make.* Ask students to *share in partners* how they could check their toy as they work to make sure it aligns with the Design Brief goals, by asking questions like: *Do we have 3 materials? Are the materials staying connected? Does the toy bend?* Remind students that while they should try to follow their plan, they may need to make changes as they work such as trying a different material if their planned material runs out or does not work with the other two materials. 4. *Teamwork:* Send the teams of two to work tables to follow their plan and make a toy together that can bend and has at least three different materials in it. If a team finishes making one toy but other teams are still working, have them start a new plan and create a second toy until all are finished with their first toy. As a team is working, ask them questions to help focus their attention on close observation. Questions like these will help the teams think together:	Student pairs discuss the importance of safety. Different pairs of students demonstrate correct use of the available tools. Students find a partner and discuss their plan and the Design Brief. Student pairs work with materials to construct their toys.	

Teacher Says/Does	Student Says/Does	Language requirements
• *How many different materials are you using?* • *What are some ways you can connect those materials?* • *Who can you ask for help if you get stuck? (Another engineering team)* • *Does each person in your team share in the fun?* 5. *Come together* when they have all finished. Each engineering team should present their products to the class and talk about what they made. Teachers may prompt students with sentence stems. 6. Guide team presentations using questions such as these to connect the Design Brief with team work: • *What is the name of your bendable toy? Why did you choose this name?* • *How does your toy bend?* • *What three materials did you use in your toy?* • *Did everyone have interesting jobs to do?* • *Why do we like/not like working in teams?* • *When do grown-ups work in teams?* 7. *Display* the items the children have made by beginning a Design Gallery in the hall of the school. 8. <u>Natural Extensions into the Disciplines: Language Arts</u> Have the teams dictate stories about what challenges they overcame while making their own toy.	Student pairs present their toys to the class and discuss the building process.	Sentence stems: "My bendable toy is called…" "We used ____, _____, and _____ to make our toy." "I liked/didn't like working in teams because _____." "Grown-ups work in teams when _____."

Names: _____ Date: _____

Bendable Toy Design Brief

1. Ask questions to be sure you understand the Design Brief!	
2. Make a plan before you work.	
3. Remember safety rules.	
4. Check what you make.	

Unit 4 (Structures): Containers and Boxes

Concept
Solid objects have differently shaped faces.

Content Objective
Students compare faces of solid figures and match shapes to the containers and boxes that came from home.

Language Objective
Students will listen to the teacher explain that edges are the sides of structures and faces are the surfaces of structures as this information is visually supported by the Figure 6 visual, the 3D objects, the boxes and containers that students can physically touch.
Students will use academic language to describe their box or container as they trace its faces with a partner including "edges," "faces," and "structure."

Standards

- **NGSS:**
  - **K-PS2-1.** Conduct investigation comparing strengths and directions of pushes and pulls on motion of object.
  - **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.
- **TEKS:**
  - **1A** identify and demonstrate safe practices as described in the Texas Safety Standards during classroom and outdoor investigations, including wearing safety goggles, washing hands, and using materials appropriately (identify)
  - **2D** record and organize data and observations using pictures, numbers, and words (organize data)
  - **3B** make predictions based on observable patterns in nature such as the shapes of leaves (predict from patterns)
  - **3C** explore that scientists investigate different things in the natural world and use tools to help in their investigations (connect to adult scientists)
  - **4A** collect information using tools, including computers, hand lenses, primary balances, cups, bowls, magnets, collecting nets, and notebooks; timing devices, including clocks and timers; non-standard measuring items such

as paper clips and clothespins; weather instruments such as demonstration thermometers and wind socks; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
    - **5A** observe and record properties of objects, including relative size and mass, such as bigger or smaller and heavier or lighter, shape, color, and texture (prop of objects)
- **ELPS:**
    - **Listening 2A:** Distinguish sounds and intonation patterns of English with increasing ease [phonological awareness]
    - **Listening 2E:** Use visual, contextual, and linguistic support to enhance and confirm understanding of increasingly complex and elaborated spoken language [Context Clues]
    - **Listening 2F:** Listen to and derive meaning from a variety of media such as audio tape, video, DVD, and CD ROM to build and reinforce concept and language attainment [Listening Across Contexts]
    - **Reading 4G:** recognize directionality of English reading such as left to right and top to bottom
    - **LLS 1E:** Use accessible language and learn new and essential language in the process [Transfer]

Suggested Literature Connections:
"Perfect Square" by Michael Hall

Materials:
Funnels of different sizes; newsprint; crayons; cardstock paper; paper; recycled plastics: oatmeal & cereal boxes, aluminum cans; milk cartons; paper towel rolls. Solid Geometric Shapes: triangular prisms, cubes, rectangular prisms, pyramids, cylinders, cones.

Suggested Activity Centers
- **Sorting faces:** Let students sort various objects into categories by the number of faces the shapes have, and by the shapes of their faces.
- **Sorting objects and containers:** Let students sort objects and their containers according to shape, or by their own categories.
- **Reading/Listening:** Listen to audio books about shapes. Ideally, partner students with a student who is reading and can support the other student in matching finger to text as they listen.
- **Math:** Use tangrams or pattern blocks to create matching designs
- **Cooking:** Sort macaroni by shapes
- **Collage:** Make a collage from side panels and fronts of boxes such as cereal boxes

Day 1: Engage/Explore *Structures: Containers & Boxes*

Teacher Says/Does	Student Says/Does	Language requirements
1. *Remind* students that during the last activities, they have become engineers since they now think a lot about the best materials for things that they will make. Remind students that engineers design many things that we use and enjoy every day. Put together a quick PowerPoint of photographs showing things that engineers have helped to create, either located in your community or that they are familiar with, e.g. your school, other local buildings, bridges, airplanes, bicycles, their favorite toys or cereals, as well as carnival rides. Show the PowerPoint and ask students to *share with a partner*: What things or places have engineers helped make? 2. *Show* the photograph of the carnival rides, again. Ask students to think in their minds about what other things engineers must think of as they are getting ready to design and make something. Provide the following scenario and have students first *share in partners* and then whole class: Suppose an engineer is getting ready to design a carnival ride made out of steel and plastic. • *What else must she or he decide when planning the carnival ride? Think back to when you were designing your bendable toy.* • *What do they need to plan?* (Answers may vary and will probably include "What it will look like, what it will be shaped like, how big it will be, what color it will be," and so on. Scribe students' ideas on chart paper. 3. *Explain* that students are describing the STRUCTURES that engineers are concerned with.	Students discuss the work of engineers in their community. Students share their ideas with partners and then the whole group.	Vocabulary: *structures, edge, faces.* Our community has _____. Engineers helped make the (different parts of the place or thing).

Teacher Says/Does	Student Says/Does	Language requirements
Structures are the shapes and supports of things that keep them strong. Some structures also provide space. Structures have different parts, and have different shapes. Introduce or come up with a gesture together to support students' understanding of the word STRUCTURES, e.g. flexing your biceps to remind students that structures keep the object strong. Have students chorally repeat the word while doing the accompanying gesture. Teachers may decide to use this as their transition signal.	Students create a gesture representing 'structures' and repeat the word several times.	
4. *Hold up* one of the boxes or containers, and ask students to describe the parts of the box. Present the word EDGE to students, demonstrating its meaning by running your finger along the different edges, or sides, of the box. Look at **Figure 5** below for reference.		
5. *Ask* students to share in partners to answer the question: *How many edges do you think it has?* Let them run a finger along an edge, counting how many edges there are as a class.	Student pairs discuss their ideas about the number of edges.	The _____ has _____ edges/faces.
6. *Show* students the FACES of the structure. Count together the number of faces, or flat surfaces, on the prism. The illustrated prism on **Figure 5** has six faces. Introduce models of other 3D objects such as a cylinder and a cone. Ask students to share with their partners how many edges and how many faces they each have, as 3D objects are passed around. Cylinders have three faces: two circles and one large rectangle. A cone has two: one circle and one half-circle.	Students count the number of faces as a whole group. Students discuss the number of edges and faces that each structure has.	
7. *Review* circle, square, and rectangle shapes for the faces. Find a shapes song online such as the one		

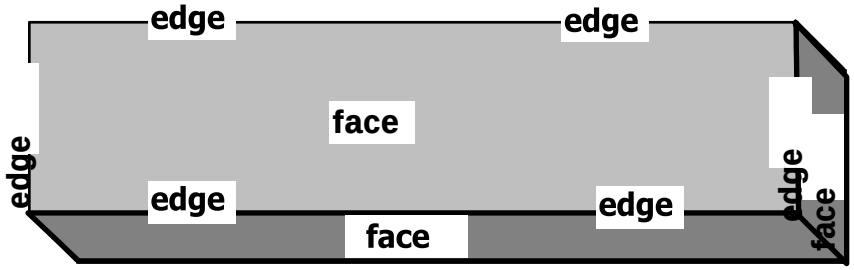
Teacher Says/Does	Student Says/Does	Language requirements
below. Encourage students to stand up and sing along to the following shape song videos. a. https://www.youtube.com/watch?v=2cg-Uc556-Q b. https://www.youtube.com/watch?v=xJxg0kR8yNc 8. *Discuss* with students how they could find out the number and shapes of faces in structures.	Students watch and sing along with the video.	

Day 2: Explain/Elaborate/Evaluate *Structures: Containers & Boxes*

Teacher Says/Does	Student Says/Does	Language requirements
1. *Review* FACES and EDGES with a few of the 3D objects, asking student volunteers to come to the front and lead the class in chorally counting the number of faces and edges.	Individual students lead whole group counting of faces and edges.	
2. *Connect* the concepts of 3D objects and of faces and edges to boxes and containers. Hold up a box and ask students if it looks like any of the 3D objects. Have them share in partners. Ask them to point out the edges and faces. Repeat these steps with different-shaped containers.	Student pairs discuss their ideas.	This structure looks like a _____ because the _____ has _____ faces/edges.
3. *Model* for students how to trace around the faces of a solid structure. If teachers use cylindrical containers, students can trace the circles at the bottom and top and can set the container on its side and trace around it. The width would not exactly match but would give students the general idea of the faces.		
4. Teamwork: Have students work in engineering teams of two to select a container or box and trace the faces. Fast finishers can trace a second container or box. As teams work, pose questions such as: *Where are the faces? Where are the edges? How many faces does your structure have? How many edges? What shape are the faces?*	Student teams work together to trace the faces of a container.	
5. *Come together* once all have finished and lead a discussion: • *Which structures have mostly rectangles or squares for faces?* • *Which structures have circles for faces?* • *If you wanted to trace a circle, which structures could you use?*	Students discuss their ideas with partners and in the whole group.	Sentence stem: "My structure has __edges/faces."

Teacher Says/Does	Student Says/Does	Language requirements
• *How could we sort out the structures by their face shapes?* Questions about structures and space might include an investigation into forces: • *Where are pushes and pulls happening on a box of cookies or crackers?* • *What do engineers invent to solve problems like crushed cookies?* • *What containers are breakable? Permanent? Temporary?* 6. *Guessing game:* As a closing activity, have each engineering pair turn to the pair next to them and guess which structure the team traced onto the paper, judging by the shapes of its faces.	Student teams play guessing game with another team.	

Figure 5 *Structures: Containers & Boxes*



Unit 5 (Structures): Flat Space

Concept
The space in a structure can be flattened out.

Content Objective
Predict shapes of boxes when flat by using cut paper rectangles.

Language Objectives
Students will learn the meaning of the word "blueprint" that is used for engineering design
Students will orally share predictions structures that are flattened out
Students will use high-frequency Math words necessary for describing structures that are flattened out: *shapes, rectangles, squares.*

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-PS2-1.** Conduct investigation comparing strengths and directions of pushes and pulls on motion of object**.**
- **TEKS:**
  - **2E** communicate observations with others about simple descriptive investigations (communicate observations)
  - **3B** make predictions based on observable patterns in nature such as the shapes of leaves (predict from patterns)
  - **6C** observe and describe the location of an object in relation to another such as above, below, behind, in front of, and beside (relative location of objects)
- **ELPS:**
  - **1A** Use prior knowledge and experiences to understand meanings in English. [Prior knowledge]
  - **1D** Speak using learning strategies such as requesting assistance, employing nonverbal cues, using synonyms & circumlocution (conveying ideas by defining or describing when exact English words are not known) [Making Meaning]

- **3A:** Practice producing sounds of newly acquired vocabulary such as long and short vowels, silent letters, and consonant clusters to pronounce English words in a manner that is increasingly comprehensible. [Phonemic Production]
- **3E** Share information in cooperative learning interactions [Communicative Competence]

Suggested Literature Connections:
"The Birthday Box" by Leslie Patricelli

Materials:
Cardboard container boxes (cereal, etc.); cut construction paper shapes; paste; markers; newsprint paper; paper

Teacher Preparation

Arrange for a guest to come talk to the class about the importance of blueprints as planning tools. Also, take a cereal or other recycled box and peel it apart at the seam. Flatten it out, smoothing all of the faces. Then, lightly tape the sides so that it looks like a whole box again.

Suggested Activity Centers

- **Map-Making:** Let students work with maps as plans for how to get somewhere.
- **Teddy Bear House:** Students draw a picture plan of a house they would like to make for their teddy bear.
- **Make a Box:** Students try folding a piece of paper into a box, and number the faces.
- **Multimedia**: Students audio-record a plan for making a peanut butter sandwich and then try to follow someone else's sandwich

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Connect to the prior lesson on bendable toys. Review the importance of having a plan. Ask the students to share with a partner how making a plan first helped them when they made a bendable toy. A plan is like a map that tells them where to go. Ask them to share in partners what would happen if they hadn't made a plan when they made the bendable toy. Share an invented plan of your first toy where you drew a bendable toy but forgot to include the materials and the tools, and your second plan that was complete and guided you effectively. Is it better to have a plan or not when creating a product? Ask students to show thumbs up for "yes" and thumbs down for "no." 2. Introduce that it can be difficult to draw things we haven't yet made, so we use our imagination, and sometimes we have to guess when making our plan. 3. Review basic shapes, including rectangles and squares, by having students chorally sing a shapes song or follow along with a video online. 4. Hold up the empty cereal box. Point to the front face of the cereal box and ask students to share in partners the name of the shape (either rectangle or square; use handout (**K.5.1**) as a guide if needed). Ask them to share in partners their predictions for what the back of the box is shaped like. Do the same with the sides and the bottom—have the students predict the shapes. Ask them to explain their answers. *How many faces or sides does the box have?* Chorally count them with the children. 5. Describe and analyze the box. Ask students*: Is the top just like the bottom? How are they different?* (The top	Students describe experiences making bendable toys Students review basic shapes by identifying them on the sides of a cereal box	Vocabulary: Rectangles/squares Bendable toys

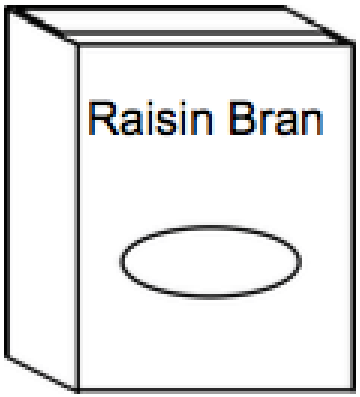
Teacher Says/Does	Student Says/Does	Language requirements
may have a tab and a slit to connect the sides closed.) Ask the students to share in partners how the box top works, e.g. it connects and disconnects when you want it to. Analyze the opening and closing end of the box. Ask students to share in partners and pose the question: *What makes it work?* Ask the children to describe its features. Remind the children to observe closely. 6. Ask the students to close their eyes and imagine what the box will look like if the box lies flat on the floor. 7. Tell the students that you will open the box out flat because you have removed the glue from the sides, and display the opened-flat cereal box as seen in the figure in the handout. Ask student to raise their hands if the box matched what they imagined.	Students describe the features and analyze the workings of a cereal box	

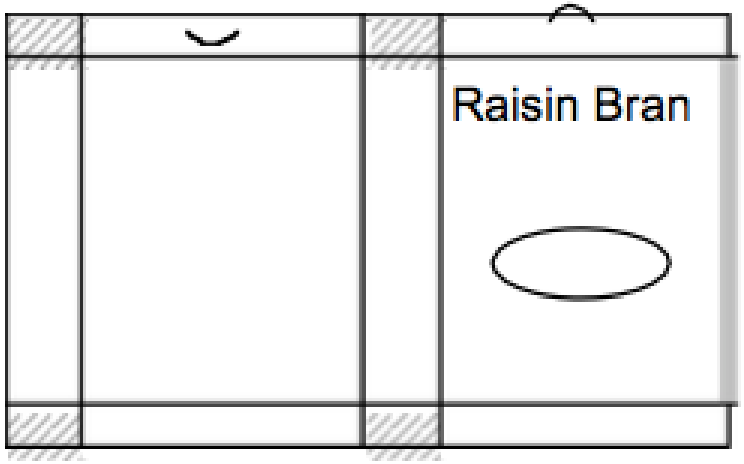
Day 2: Explore/Explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Blueprints. Tell the students that they can predict the shape of objects like this box with sketches using cut paper pieces. These pictures that help predict or plan are what engineers call “blueprints”. Chorally say the word together a few times with students. Guide students in creating a gesture for “blueprints” such as one hand symbolizing paper and another hand drawing on it. Inform students that they will get to create their own blueprints of the cereal box to imagine what that cereal box, or structure, will look like when it is flat. 2. Briefly display the opened-flat cereal box and then remove it from view as students begin to work to encourage students’ predicting rather than copying. Remind students to use their imaginations and creativity in making their blueprints of the cereal box. 3. Hand out cut paper shapes to engineering teams of two students. Each team should receive narrow rectangles and wide rectangles to work with. (Alternatively, you can ask students to trace their cereal box faces, then cut out the shapes, using those for their blueprint.) 4. Have the student teams use the cut paper shapes and make pictures (blueprints) of what they think the box will look like when it’s laid flat. They can simply place the cut shapes onto the floor, moving them around until they are arranged as they wish. Then they can push the arrangement into the area in which the other groups can see what they have done. As teams are working, check in with them and model using the word “blueprints” when posing questions to them.		Vocabulary: blueprint/sketch

Day 3: Evaluate/Elaborate

Teacher Says/Does	Student Says/Does	Language requirements
1. Gallery walk. Once all engineering pairs have finished their blueprints, tape them up on the walls around the room. Have students walk around the room to observe and analyze each blueprint. Ask them to think about which ones are the same and which are different. After the gallery walk, have students find a partner different from their engineering partner and share their observations/analysis. Students may interchange the words “pictures” and “blueprints” as they are analyzing the blueprints. 2. Come back together. Ask engineering pairs to bring their blueprints with them. Share out some observations and analysis of the blueprints. You may decide to encourage students to avoid saying students’ names when sharing observations and analysis whole group. Then lay the cut cereal box flat and compare the blueprints to the flattened box. Have the students, in their pairs, check their blueprints and see if they can find where the plans differ from the actual flat box. 3. Self-evaluate. Ask students to self-evaluate the teamwork in making the blueprints to find out how well they worked with their partner. Pose questions such as: Did both members contribute ideas? Did both members help trace or draw? Have students show fingers to kinesthetically respond: 3 fingers=Definitely, 2 fingers=Sometimes, 1 finger=No, we probably need to work on that. If any teams need to be re-configured, now is a good time to do it. 4. Using handout (**K.5.2**), have student pairs work on writing, drawing, giving a synonym and describing the meaning of the word "blueprint"		





fold flaps—close gaps

glue flap—gives a surface to glue box at seam

Name: _____ Date: _____

(Write the word)	(Give an example)
(Describe it in your own words)	(Another word with same meaning)

Unit 6 (Structures):
Inside-Out Boxes

Concept
Boxes can be reversed and new structures can be made with them

Content Objective
Use reverse-box construction to make new structures

Language Objectives
Students will deepen their understanding of the meaning of the word "blueprint" that is used for engineering design
Students will use design engineering vocabulary (structure, design brief) as part of discussions
Students will access prior knowledge by discussing with a partner about different kinds of materials, their characteristics, and their uses.
Students will listen to the teacher orally explain the Design Brief task, and will orally share questions they have

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** ask questions about organisms, objects, and events observed in the natural world (ask)
  - **2E** communicate observations with others about simple descriptive investigations (communicate observations)
  - **3B** make predictions based on observable patterns in nature such as the shapes of leaves (predict from patterns)
  - **4A** collect information using tools, including computers, hand lenses, primary balances, cups, bowls, magnets, collecting nets, and notebooks; timing devices, including clocks and timers; non-standard measuring items such as paper clips and clothespins; weather instruments such as demonstration thermometers and wind socks; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)

- **ELPS:**
    - **Listening 2G:** Understand the general meaning, main points, and important details of spoken language ranging from situations in which topics, language, and contexts are familiar to unfamiliar [LC: Abstract & Concrete]
    - **Speaking 3G:** Express opinions, ideas, and feelings ranging from communicating single words and short phrases to participating in extended discussions on a variety of social and grade-appropriate academic topics; [Speech Production @ Grade Level]

Suggested Literature Connections:
"Not a Box" by Antoinette Portis

Materials:
tape dispensers; construction paper; design brief written on colored paper; cereal or other recycled boxes, assorted shapes; markers; paint and newspaper; cleanup supplies

Design Brief
Make a structure that 1) is an inside-out box, 2) holds its shape, 3) has six faces or sides, 4) is pleasing to look at, and 5) has one face that can open and shut

Suggested Activity Centers:
- **Everyday Objects:** Students turn objects like plastic bags, their socks and shirts inside-out. Do the articles look the same?
- **Name Reversal:** Students write their name with crayon on paper, then place a clean sheet over it and rub hard with a ruler. The print of their name is reversed.
- **Art:** Draw an inside-out Teddy bear, an inside-out apple, or an inside-out jacket.
- **Box Study:** Students look at several boxes and analyze the ways they open and shut.

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Remind students about the previous lessons in which you opened flat a cereal box. Review the meaning of the word "BLUEPRINTS" with students, or what they drew to show what their structure (the cereal box) would look like flat. Chorally repeat "BLUEPRINTS" with students and ask them to use the accompanying gesture. Pose the question: *How many sides/faces did the boxes have?* Ask students to share in partners before sharing whole class. 2. Explain that some boxes can be turned inside-out and the sides taped together to make a new box. Demonstrate this to the students, and have a student come up to help tape up the sides of the opened-up box. Remind them that this is where teamwork is especially helpful. 3. Ask the students to describe the new box you have made. Create a Venn diagram (use handout (**K.6.1**) as a guide) to compare and contrast the new box with the old. Pose questions for students to share in partners such as: *How are the new and old boxes similar? How are they different? How many faces did the old box have? How many faces does the new box have?* Call on partners to share ideas aloud and add to the Venn diagram. Chorally count the number of faces. Ask them if the new box is more pleasing to look at than the old box was. The designs and lettering is gone, for example, and this may make the box easier to decorate and more pleasing to look at. *4.* Ask the children. Have students share in partners to analyze how the inside-out box works. Pose questions	Students share previous activity making a blueprint with cereal boxes Students compare old and new box structures Students share with partners how the inside-out box opens and shuts	Vocabulary: Blueprints

Teacher Says/Does	Student Says/Does	Language requirements
such as: *How does the inside-out box open? Shut? How might you change the box so it opens? Shuts?*		

Day 2: Explain/Elaborate

Teacher Says/Does	Student Says/Does	Language requirements
1. *Show* the students the Design Brief. Form the students into engineering teams of two. Display your visual of the Design Brief (see below). 2. *Display* the Design Brief **Design Brief-Make a structure that:** **1. Is an inside-out box** **2. Holds its shape** **3. Has six faces or sides** **4. Is pleasing to look at, and** **5. Has one face that can open and shut** 3. *Remind students* of the steps in solving the problem in the Design Brief and display your visual of the steps with accompanying pictures with handout (**K.6.2**): Step 1. Ask questions to be sure you understand the Design Brief! Step 2. Make a plan before you work. Step 3. Remember safety rules. Step 4. Check what you make. 4. *Ask questions.* Go over each specification or rule of the Design Brief, using "wait time" between questions and having students share in partners before asking questions to the whole group so that each item is covered in depth. Ask students what "pleasing to look at" means and what kinds of materials they might use to	Students ask questions and share ideas about the Design Brief	structure design brief blueprint

Teacher Says/Does	Student Says/Does	Language requirements
accomplish this. Display available supplies such as paint, pencils, markers, construction paper, tape and/or glue that they will have access to. 5. *Make a plan.* Tell the students that when they plan with their partner they should make a blueprint with cut paper shapes (that teacher supplies), or draw how their structure will look and how it will open and shut. Ask them to think about which materials they would use to accomplish the Design Brief task. Create a checklist for the engineering pairs to reference as they make their blueprint, including each rule of the Design Brief with a visual or sketch next to each rule. 6. *Come together* to share completed blueprints. Ask each engineering pair to share their blueprints with another pair, and give positive feedback. Teachers could select one or two blueprints that they feel are especially creative or unique and ask students if they can share them with the class.	Students share and discuss their blueprints	

Day 3: Explain/Elaborate

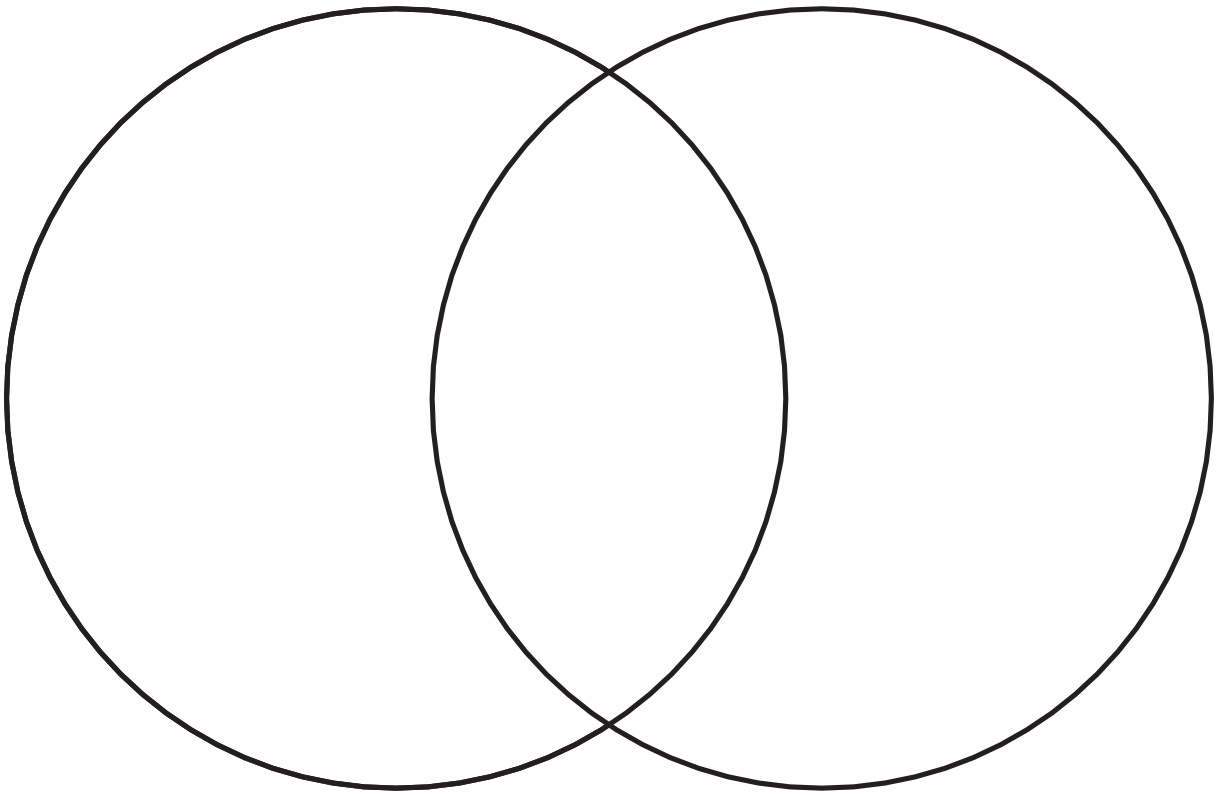
Teacher Says/Does	Student Says/Does	Language requirements
1. *Practice* the word “BLUEPRINT” through choral repeat and the gesture. Ask students to share in partners what they accomplished last lesson. Inform them that, today, they will put their plans into action to create a new structure from an old structure. 2. *Display* the Design Brief as well as the steps. Go over steps 3 and 4 with students. Ask them to share in partners what it would look like to be safe while creating their inside-out boxes, and how they could check what they make. Share out ideas whole class. 3. *Teamwork.* Have engineering pairs get their blueprints and their checklists, and then select a box and bring it to you if they need help peeling the seams apart. If you have different-sized or –shaped boxes, you may want to let students select a box beforehand so that they can look at it during the planning stage. As teams are working, observe, pose questions, and take anecdotal notes of students’ understanding of the Design Brief.		blueprint design brief

Day 4: Evaluate

Teacher Says/Does	Student Says/Does	Language requirements

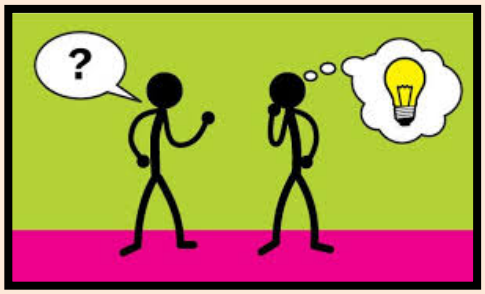
• *Add* to your own class log what the teams did during the last activity & the methods they used.
• *Bring teams together* to evaluate once teams have completed their structure with an inside-out box, and guide them in presenting their blueprints and structures by asking questions such as those below:
  • *Was it difficult to turn the box inside out?*
  • *How did partners help each other?*
  • *How did you test the structure to find out if it holds its shape?*
  • *Tell about how the door opens and closes.*
  • *What was the most fun about making your inside-out box?*
  • *Show your blueprint and how it looks like your inside-out box.*
• *Sharing writing.* Take dictation from teams as they describe their product. Display the structures in Design Gallery w/student dictations.
	Team share the process they used to design their blueprints and structures	

OLD BOX NEW BOX



Names: _____ Date: _____

Bendable Toy Design Brief

1. Ask questions to be sure you understand the Design Brief!	
2. Make a plan before you work.	
3. Remember safety rules.	
4. Check what you make.	

Unit 7 (Mechanisms):
Exploring Wheels and Axles

Concept
Mechanisms are parts of structures which create or use motion. Wheels are mechanisms.

Content Objective
Explore shapes that do and do not roll.

Language Objectives
Students will use the following high-frequency English words to identify and discuss different kinds of movement and vehicles: *roll, slide, float, vehicle, boat, sled, bicycle, bus*
Students will listen to the teacher orally explain the Design Brief task, and will orally share questions they have
Students will orally share their ideas and work putting a wheel on a cereal-type box in order to make the wheel turn.

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.
- **TEKS:**
  - **1A** identify and demonstrate safe practices as described in the Texas Safety Standards during classroom and outdoor investigations, including wearing safety goggles, washing hands, and using materials appropriately (identify)
  - **2B** plan and conduct simple descriptive investigations such as ways objects move (investigate movement)
  - **3B** make predictions based on observable patterns in nature such as the shapes of leaves (predict from patterns)
  - **4A** collect information using tools, including computers, hand lenses, primary balances, cups, bowls, magnets, collecting nets, and notebooks; timing devices, including clocks and timers; non-standard measuring items such as paper clips and clothespins; weather instruments such as demonstration thermometers and wind socks; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
  - **6D** observe and describe the ways that objects can move such as in a straight line, zigzag, up and down, back and forth, round and round, and fast and slow (how objects move)
- **ELPS:**
  - 1A Use prior knowledge and experiences to understand meanings in English.

- 4A Learn relationships between sounds and letters of the English language to represent sounds when writing in English.
- 1C Use strategic learning techniques such as concept mapping, drawing, memorizing, comparing, contrasting and reviewing to acquire basic and grade-level vocabulary.

Suggested Literature Connections:
"Wheels!" by Annie Cobb

Materials:
Assorted objects to test (e.g., cereal or oatmeal boxes; cans; milk cartons; cardstock paper; spools; paper towel rolls; ping pong balls; wooden blocks; funnel; marbles; dominoes; toy car)

Day 1: Engage/Explore

Teacher Says/Does	Student Says/Does	Language requirements
1. Gather all students on the rug and show three or four objects from the materials list. Or show pictures for these materials in the handout (**K.7.1**). Ask the following questions: *What is this? What is it for?* Invite students to point out and name each of the objects and share what they know about them. 2. Divide the students into pairs and give each pair one object from the materials list that either rolls or slides. 3. Demonstrate and discuss how some objects will roll and others will slide. 4. Ask pairs of students who have objects that can roll to stand up. Have each pair demonstrate why they can think the object rolls. 5. Next, ask pairs of students who have objects that slide to stand up. Have them take turns to demonstrate why they think their object slides. 6. Show them the *The Little Engine that Could* video: https://www.youtube.com/watch?v=8EhpqcXoxGI 7. Show students a picture of a toy car. *What has to happen before a toy car can roll?* Give students toy cars and have them describe what is happening as the wheel turns. Let them explain to each other.	Students point at objects in the material list or at pictures on handout and share what they know about them. Students share words that rhyme with "slide" and with "roll" Student pairs explain their understanding of sliding and rolling objects Students share what they know about cars	This is a_____ It is used for_____ One word that rhymes with slide is_____ One word that rhymes with roll is_____ We think this object slides because_____ We think this object rolls because_____

Day 2: Explain/Elaborate

Teacher Says/Does	Student Says/Does	Language requirements
1. Go on a walk and find some things that vehicles do and how they travel. Or show them pictures of a bicycle, a sled, a boat and a bus from the handout (**K.7.3**). 2. Ask the following questions: •*What are vehicles for?* •*What do they do?* •*How do they move?* •*Which vehicles don't have wheels?* 3. Write down the children's ideas as you go and read them back to the children when you return. 4. Do a choral reading of the paragraph constructed from children's ideas 5. Show cards with the words "slides" and "rolls" (handout (**K.7.2**)). Read the words with the students. Ask students if the vehicles they saw on the visit rolls or slides. 6. (Boats, sleds) *How do they travel?* (They float, or slide.) *Do the vehicles we saw today slide? Why not?* 7. Once they respond that the vehicles don't slide, ask students why not? 8. You might want to let some of the children explore with the concept of rolling vs. sliding in simple experiments. 9. Form student pairs and ask them to analyze the pictures in the handout (**K.7.3**), decide if the vehicle slides or rolls, and put a checkmark on it. 8. Have students talk about the vehicles they saw and about the pictures of vehicles they analyzed.	Students share their knowledge about vehicles Children read a paragraph constructed from their ideas about vehicles Students decide if examples seen on the walk or on the handouts "slide" or "roll" and explain their choice.	Vocabulary: roll, slide, float, vehicle, boat, sled, bicycle, bus

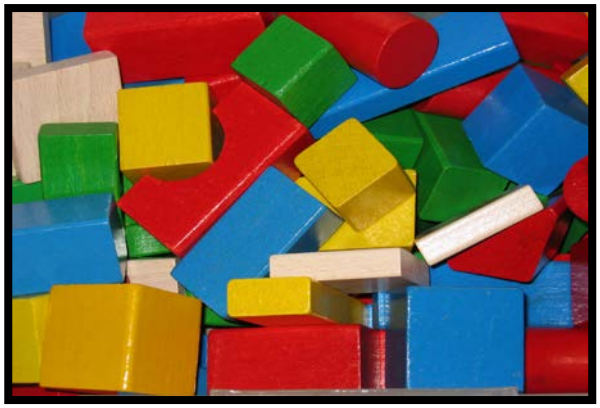
Day 3: Evaluate

Teacher Says/Does	Student Says/Does	Language requirements
1. Have students watch a video about 10 different vehicles with wheels, and ask them what they all have in common: https://www.youtube.com/watch?v=P5FvarVt3us 2. Tell them they are going to make vehicles by putting a wheel on certain materials. 3. Form student teams. Give the students access to recycled materials and ask the teams to explore ways to put a wheel on a cereal-type box so that the wheel will turn. 4. Talk about axles, and whether axles turn or wheels turn in some toys that they are familiar with 5. During the exploratory work, go to each team individually and ask questions to help them focus on the materials they are using and the results of their actions. Here are some questions for coaching: • *How did you do that?* • *What is happening to your materials when you connect them like that?*	Students decide what vehicles and wheels have in common Students explain how they put a wheel on the cereal-type box in order to make the wheel turn.	Vehicles and wheels have _____in common Vocabulary: wheel, axle

Day 4: Elaborate

Teacher Says/Does	Student Says/Does	Language requirements
1. Have the teams present some of their ways of attaching moving wheels. These students can advise others during design brief work. 2. Explore further by testing various objects on the playground slide after predicting which ones will slide, roll, or limp, etc., down the slope 3. Have students continue the exploration with rolling, sliding objects, by doing one of the following in different groups: cutting out pictures of things that roll and slide and making a collage	Student teams make a short presentation explaining how they attached a wheel on their cereal-box Students talk about playground objects and decide which ones slide, roll, limp Students make a collage with objects that roll or slide	Vocabulary: roll, slide, limp, collage

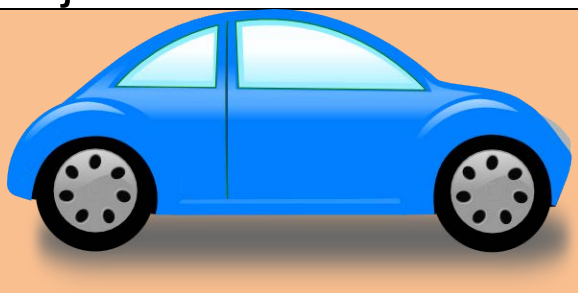
Examples of Materials:



rolls

slides

Name: _____ Date: _____

Object	rolls	slides
	√	
		
		
		
		

Unit 8 (Mechanisms): A Frame that Rolls

Concept
Axles hold wheels. Axles can be attached to a frame in different ways.

Content Objective
Try different ways to make wheels and axles that will roll.

Language Objectives
Students will learn new vocabulary regarding mechanisms (e.g., wheels, axles, frames) with the help of a graphic organizer
Students will share their understanding of the Design Brief task as applied to making a frame that rolls
Students will describe their projects using increased specificity and detail depending upon their level of oral English language development.

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.
- **TEKS:**
  - **1B** discuss the importance of safe practices to keep self and others safe and healthy (discuss)
  - **2B** plan and conduct simple descriptive investigations such as ways objects move (investigate movement)
  - **2E** communicate observations with others about simple descriptive investigations (communicate observations)
  - **4A** collect information using tools, including computers, hand lenses, primary balances, cups, bowls, magnets, collecting nets, and notebooks; timing devices, including clocks and timers; non-standard measuring items such as paper clips and clothespins; weather instruments such as demonstration thermometers and wind socks; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
  - **6D** observe and describe the ways that objects can move such as in a straight line, zigzag, up and down, back and forth, round and round, and fast and slow (how objects move)
- **ELPS:**
  - **A1** Use prior knowledge and experiences to understand meanings in English. [Prior knowledge]
  - **2D** monitor understanding of spoken language during classroom instruction and interactions and seek clarification as needed [Comprehensible Input]

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

Suggested Literature Connections:
"Roll, Slope, and Slide" by Michael Dahl

Materials:
K'nex kits (preferably); straws; beads; wooden dowels; wooden sticks; recycled round objects for wheels; cardstock paper; poster board; clay; box frames (milk or cereal); paper towel rolls; spools; glue gun; scissors; tape; wood glue; hand drill

Design Brief
Make a frame that will roll.

Suggested Exploratory Activity Centers
- **Wheel Making**: Students try to work with the junk materials to find things that would make wheels.
- **Toy Exploration**: Look at the wheels and axles on toys to find out how they turn.
- **Art**: Draw or paint pictures of objects with wheels and count the wheels.
- **Wheels of Many Shapes**: Students experiment with wheels of different shapes.
- **Sorting**: Sort pictures of objects by the number of wheels they have.

Day 1: Engage/Explore *Mechanism:*

Teacher Says/Does	Student Says/Does	Language requirements
1. Introduce the topic of the lesson by singing a song like "*The Wheels on the Bus* " with the children 2. Organize students in pairs and give each one of the pictures on the handout (**K.8.1**). Give them a few minutes to observe the picture, talk about and then share out with the rest of the class. 3. Make sure students know which figures refer to wheels and which to axles and frames. 4. Tell the students that they will experiment with ways to make wheels and axles attach to a frame on a box. Ask them to review with you what they know about axles. 5. Incorporate the following ideas into a discussion: that axles may be attached onto the body of a frame, with the wheels rotating freely on the axles. Other axles may rotate with the wheels, being held onto the frame in some sort of axle carrier. 6. Organize students in groups of 3-4. Tell them they will watch a video and will have to remember one thing about wheels or axles and share them with the rest of the class. Show them the video about simple machines with axles and wheels: https://www.youtube.com/watch?v=XlZYPFDjTJM 7. Have each group share with the class the one thing they remembered from the video	Students sing a song about wheels with the teacher Students share their observations of wheels, axles and frames Students watch a video about wheels, axles and frames and share with the rest of the class	wheels, axles, frame

Day 2: Explain/Elaborate

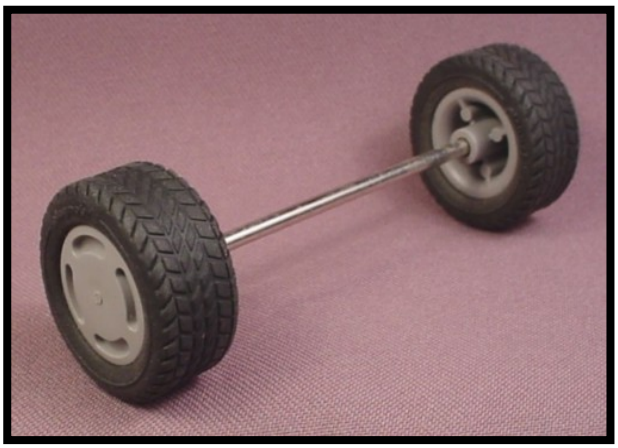
Teacher Says/Does	Student Says/Does	Language requirements
1. Before class starts, copy the Design Brief on the board or poster. Look over Figure 7 in handout (**K.8.2**) to review methods of making wheels and axles. If desired, make samples of several different ways to make wheels and axles. Put these at a table for student reference. **Design Brief:** **Make a frame that will roll** 2. Display the design brief title and read it orally with students, then read it with them. Ask them what they think it involves, and provide clarifications if necessary. Remind the student teams of how to work on the problem 3. Discuss some essential features of implementing the Design Brief: Step 1. Ask questions to be sure you understand the Design Brief. Step 2. Make a plan before you work. Step 3. Remember safety rules. Step 4. Check what you make. 4. Tell the student teams to make a sketch of their plan with crayons. 5. They should remember the SAFETY RULES about using tools and materials and wear SAFETY FIRST buttons when working at any woodcutting. Remind them of the placement of their hands when using tools. Show them again which tools are for teacher use only. 6. Let the teams work on the problem. While the teams	Students read with the teacher the sentences describing the design brief goal, share their understanding and discuss basic procedures.	Vocabulary: design brief, sketch

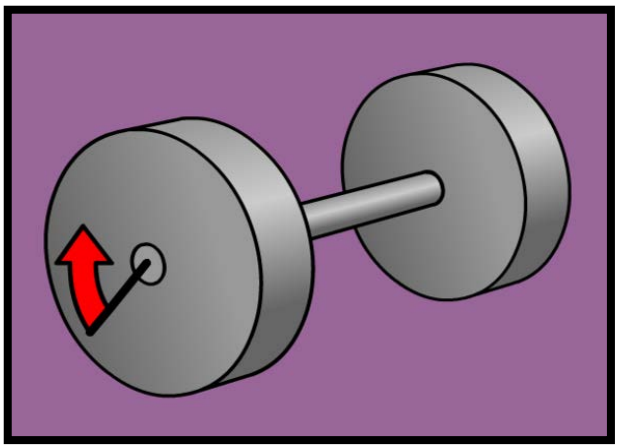
Teacher Says/Does	Student Says/Does	Language requirements
are working, visit with them and ask questions that help the children use observation, analysis, and troubleshooting skills.		

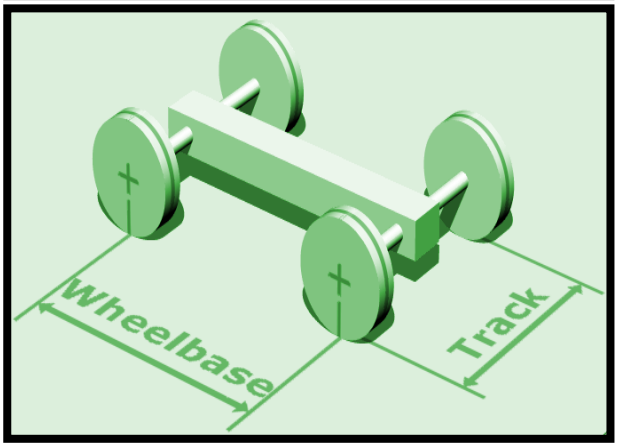
Day 3: Evaluate

Teacher Says/Does	Student Says/Does	Language requirements
1. When they have made a frame on wheels, have them show the group what they have done. You might ask these questions: • *What was the hardest part about this construction?* • *What did your team figure out to do to make it easier?* • *Does your frame roll? Did you have some trouble getting the wheels to work?* • *Tell who in the team did what jobs.* • *If you could do it again, what would you do differently?* 2. Tell the students that the next time they work on a Design Brief they will be making something to exhibit it for the entire school in a Technology Fair, and they will be able to see what other participating classes have done. 3. Write in your own class log what the teams have accomplished. Let the class help you write "Some different ways to make wheels and axles". 4. Set aside the teams' rolling frames for the next activity	Students reflect and share their reflections about their process of building a frame that rolls. Teams identify some different ways to make wheels and axles	Vocabulary: frame on wheels Sentence starters: The hardest thing about this construction was_____ Things we figured out were_____ If we were to do it again, we would not _____

Name: _____ Date: _____







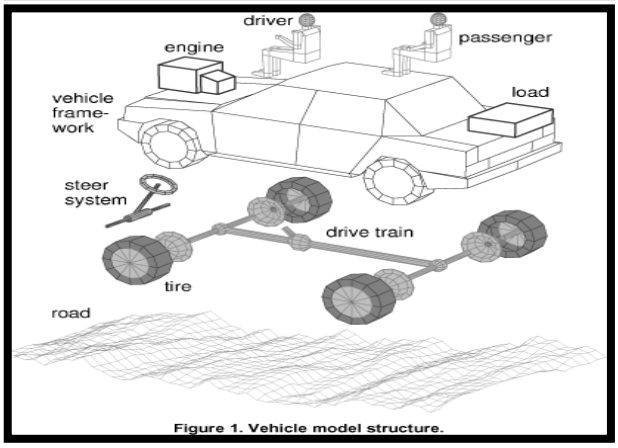
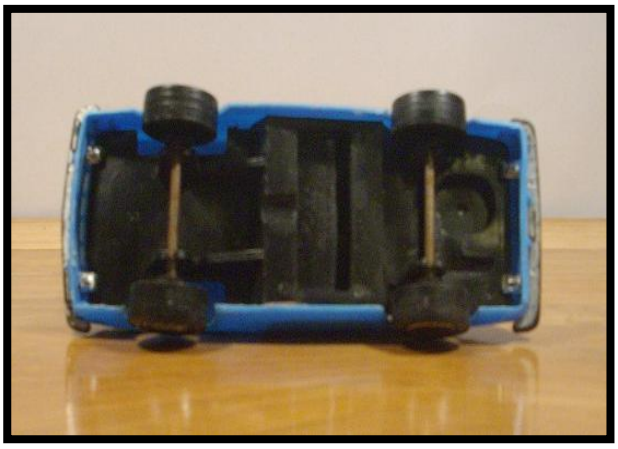
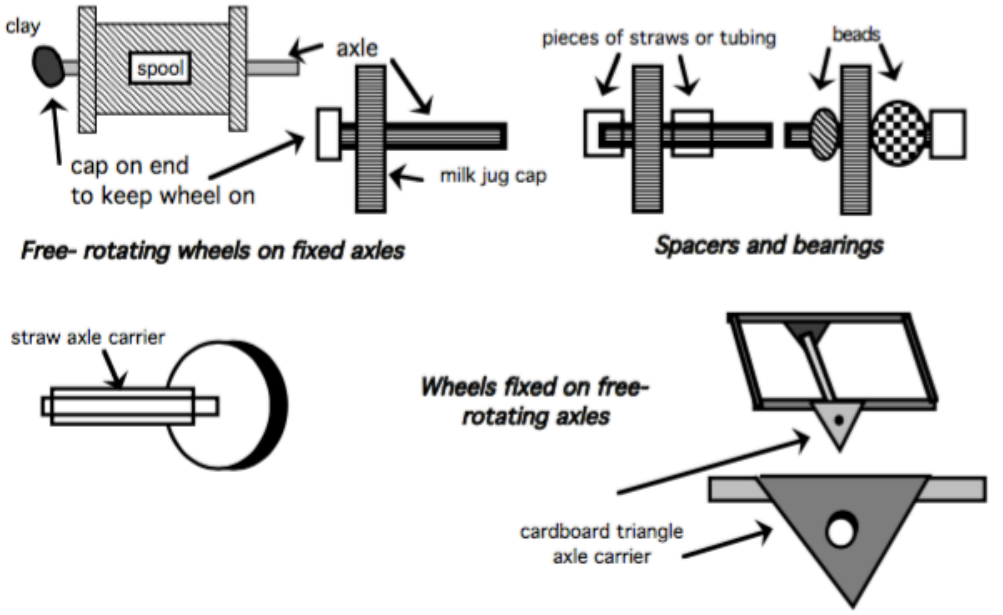


Figure 1. Vehicle model structure.





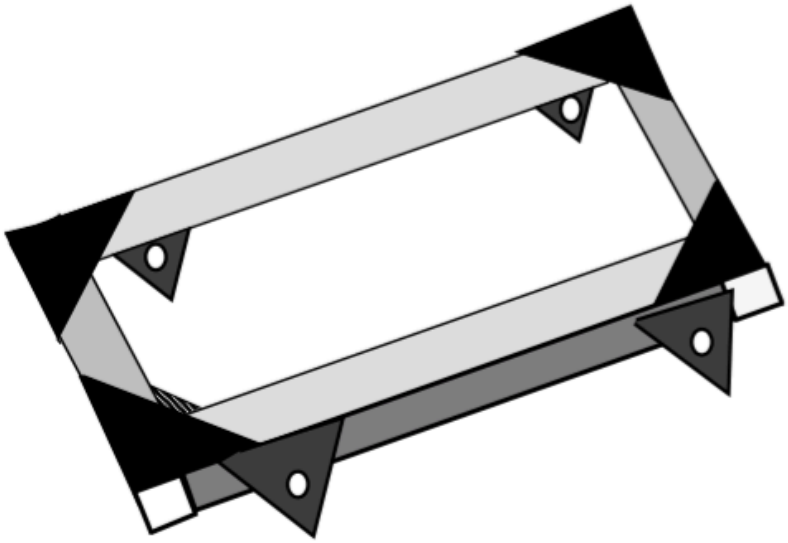


FIGURE 7. Ways to do wheels, axles and spacers

Unit 9 (Mechanisms): Creating Team Entries

Content Objective
Make working models of the product in Design Brief.

Language Objectives
Students will listen to the teacher orally explain the Design Brief task, and will orally share questions they have
Students will use high-frequency and subject-specific vocabulary learned in previous lessons
Students will describe their products using increased specificity and detail depending upon their level of oral English language development.

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.
- **TEKS:**
  - **2B** plan and conduct simple descriptive investigations such as ways objects move (investigate movement)
  - **2E** communicate observations with others about simple descriptive investigations (communicate observations)
  - **4A** collect information using tools, including computers, hand lenses, primary balances, cups, bowls, magnets, collecting nets, and notebooks; timing devices, including clocks and timers; non-standard measuring items such as paper clips and clothespins; weather instruments such as demonstration thermometers and wind socks; and materials to support observations of habitats of organisms such as terrariums and aquariums (use tools)
  - **6D** observe and describe the ways that objects can move such as in a straight line, zigzag, up and down, back and forth, round and round, and fast and slow (how objects move)
- **ELPS:**
  - **Listening 2D:** Monitor understanding of spoken language during classroom instruction and interactions and seek clarification as needed
  - **Speaking 3E:** Share information in cooperative learning interactions (Communicative Competence)
  - **Speaking 3D:** Speak using grade-level content area vocabulary in context to internalize new English words and build academic language proficiency [Application for Acquisition]

Suggested Literature Connections:
"If I Built a Car" by Chris Van Dusen

Materials:
All consumable craft and construction materials the children have used up to this point should be available to them to use in making their products (eg., boxes; paper towel rolls; construction paper; clay; milk cartons; paste; tape; etc.)

Design Brief
Make a vehicle that rolls when you push it or pull it. It should have at least one door that opens and will stay shut.

Suggested Exploratory Activity Centers:

- **Art:** Students work with wheel macaroni to make pictures of vehicles from their stories.
- **Multimedia:** Students tape-record a story about a magic vehicle.
- **Reading:** Place on display storybooks that have wheels in them, or books shaped like cars.
- **Reading/Listening:** Set up listening stations for stories like *The Little Engine That Could* and *Mike Mulligan*.
- **Math:** Students count how many turns of different-sized wheels are necessary to cover a given distance.
- Use a digital camera to take pictures of student products; children can word-process accompanying stories.
- **Cooking:** Students make pizza and cut it with a pizza wheel.
- **Sorting:** Sort model cars and wheeled toys by how fast they roll, the types of axles they have, etc.
- **Lego Car Story-Writing:** Use Legos to build vehicles that roll, then write stories about the cars they invented.
- **Teddy Bear's Trip Story-Writing:** Make a car for a Teddy bear out of a large cardboard box. Invent a story about Teddy bear's trip.

Day 1: Engage/Explore

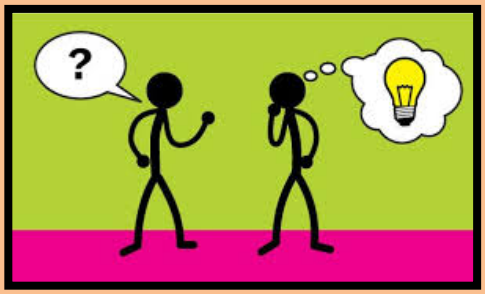
Teacher Says/Does	Student Says/Does	Language requirements
1. Show the students the Design Brief: **Design Brief** **Make a vehicle that rolls when you push or pull it. It should have at least one door that opens and will stay shut.** 2. Tell them that there is going to be a Technology Fair at the school soon, and that their teams are challenged to come up with a product that solves the Design Brief problem. Each student team will enter a product and a dictated description that names the product, tells how the team worked on it and how it was made. 3. Set the context. Remember that the product is to be inspired by some event, character, object or idea from a story, from science, or from social studies. Ask the students to name a vehicle that rolls and has a door from the story, Curious George in Africa? (or some other story). Allow students to give several ideas from your current book. For example, they may make "the car owned by the man with the yellow hat." If you are studying Community Helpers, they may make a police car or a fire truck. Another approach is to ask the children to solve a problem for a child that needs to bring a large pet to school, or needs to get some other large object across town or across the garden.	Students share ideas that might inspire their product	

Day 2: Explore/ Explain

Teacher Says/Does	Student Says/Does	Language requirements
1. Remind the student teams how important it is to think of ideas different from everyone else's. 2. Also remind the teams how to work best. Use the handout (**K.9**) to discuss the Design Brief steps: Step 1. Ask questions to be sure you understand the Design Brief. Step 2. Plan before you work. Step 3. Remember safety rules. Step 4. Check what you make. 3. When a team has finished, have them dictate to you or write a description of their product and how they made it. They should describe how they worked as a team. The written description can be displayed at the Technology Fair. Awards for the Technology Fair are non-competitive and celebrate the many differences between products and diversity of excellence. The Resources section has some examples of awards you may wish to use.	Students discuss the different stages of implementing a design Student teams dictate a description of their product to their teacher	

Names: _____ Date: _____

Bendable Toy Design Brief

1. Ask questions to be sure you understand the Design Brief!	
2. Make a plan before you work.	
3. Remember safety rules.	
4. Check what you make.