# PictureSTEM

# Designing Paper Baskets

PURDUE UNIVERSITY

INSPIRE
Research Institute for Pre-College Engineering

IOWA STATE UNIVERSITY

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**About PictureSTEM**
The PictureSTEM Project includes an instructional unit at each grade level, K-2, which employs engineering and literary contexts to integrate science, technology, mathematics, and computational thinking content instruction in meaningful and significant ways. These transformative new models for STEM+C (science, technology, engineering, mathematics, and computational thinking) learning use picture books and an engineering design challenge to provide students with authentic, contextual activities that engage learners in specific science, mathematics, and computational thinking content while integrating across traditional disciplinary boundaries. These units have been classroom tested and research has been published and is ongoing regarding student learning and teacher implementation in the classroom.

To learn more about the PictureSTEM Project and to view additional integrated STEM units, contact us:

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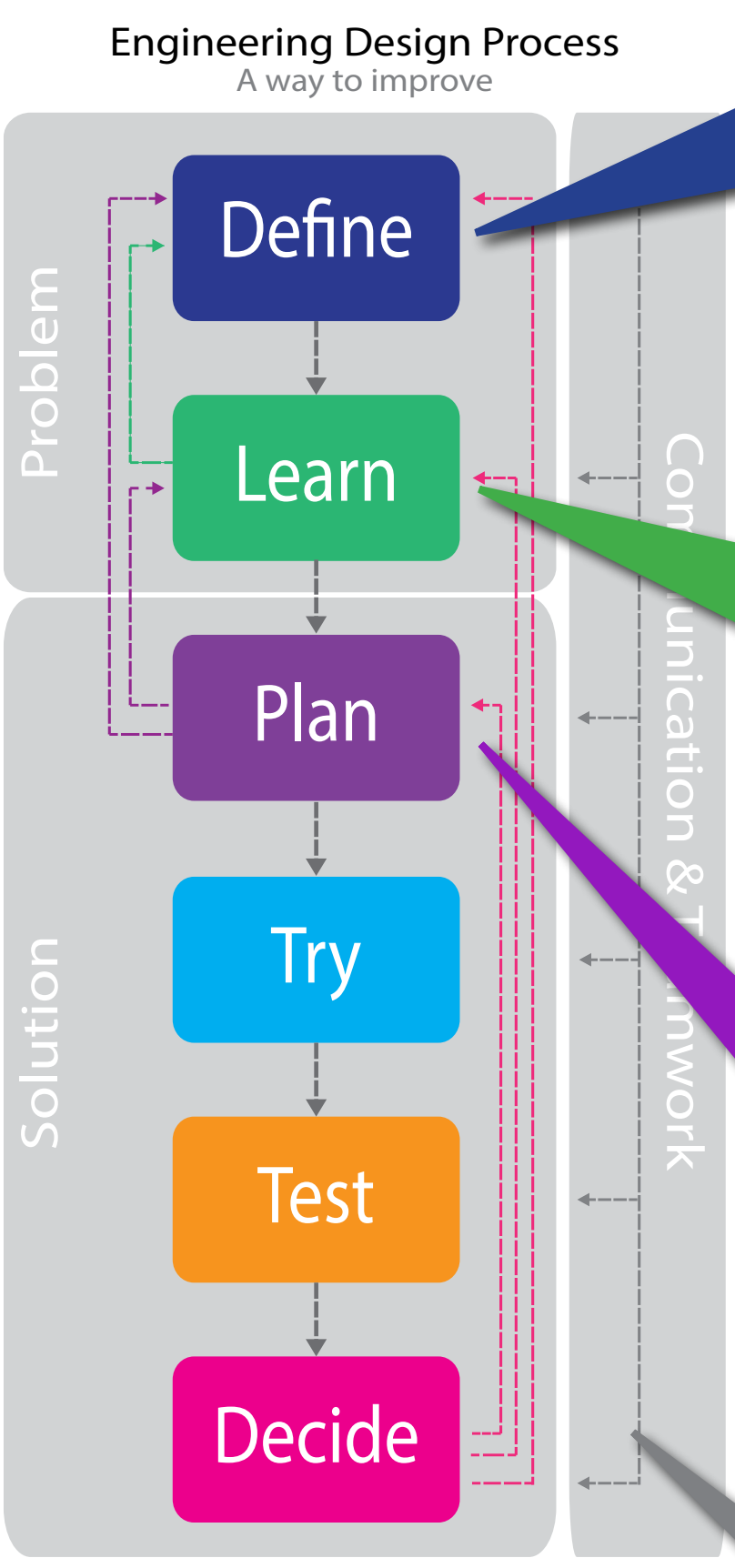
# Overview: Engineering Design Process




**DEFINE THE PROBLEM**

- Who is the **client**?
- What does the client need?
- Why does the client need it?
- Who is the **end user**?
- Why might the end user want it?
- What are the **criteria** (requirements and limits) of the solution?

Problem Scoping:
**WHO** needs **WHAT** because **WHY**

**LEARN ABOUT THE PROBLEM**

- What kind of background knowledge is needed?
  - What science/math knowledge will be needed?
  - What materials will be needed?
- What has already been done to solve the problem?
- What products fill a similar need?
- How should we measure success and improvement?

**PLAN A SOLUTION**

- Continue to specify the criteria
- Generate ideas of possible solutions
- Develop multiple solution paths
- Consider **trade-offs** (criteria that compete with one another)
- Choose a solution to try
- Develop plans (blueprints, schematics, cost sheets, storyboards, notebook pages, etc.)

**COMMUNICATION**

- Communicate the solution clearly and make sure it is easily understandable
- Use **evidence** to support why the client should use your solution

# Overview: Engineering Design Process

### TRY A SOLUTION

- Put the plan into action
- Consider risks and how to optimize work
- Use criteria and consider trade-offs from the problem/plan to build a **prototype** (a testable representation of a solution), **model**, or **product**

### TEST A SOLUTION

- Consider testable questions or hypotheses
- Develop experiments or rubrics to determine if the solution is meeting the stated criteria and needs
- Collect and analyze data

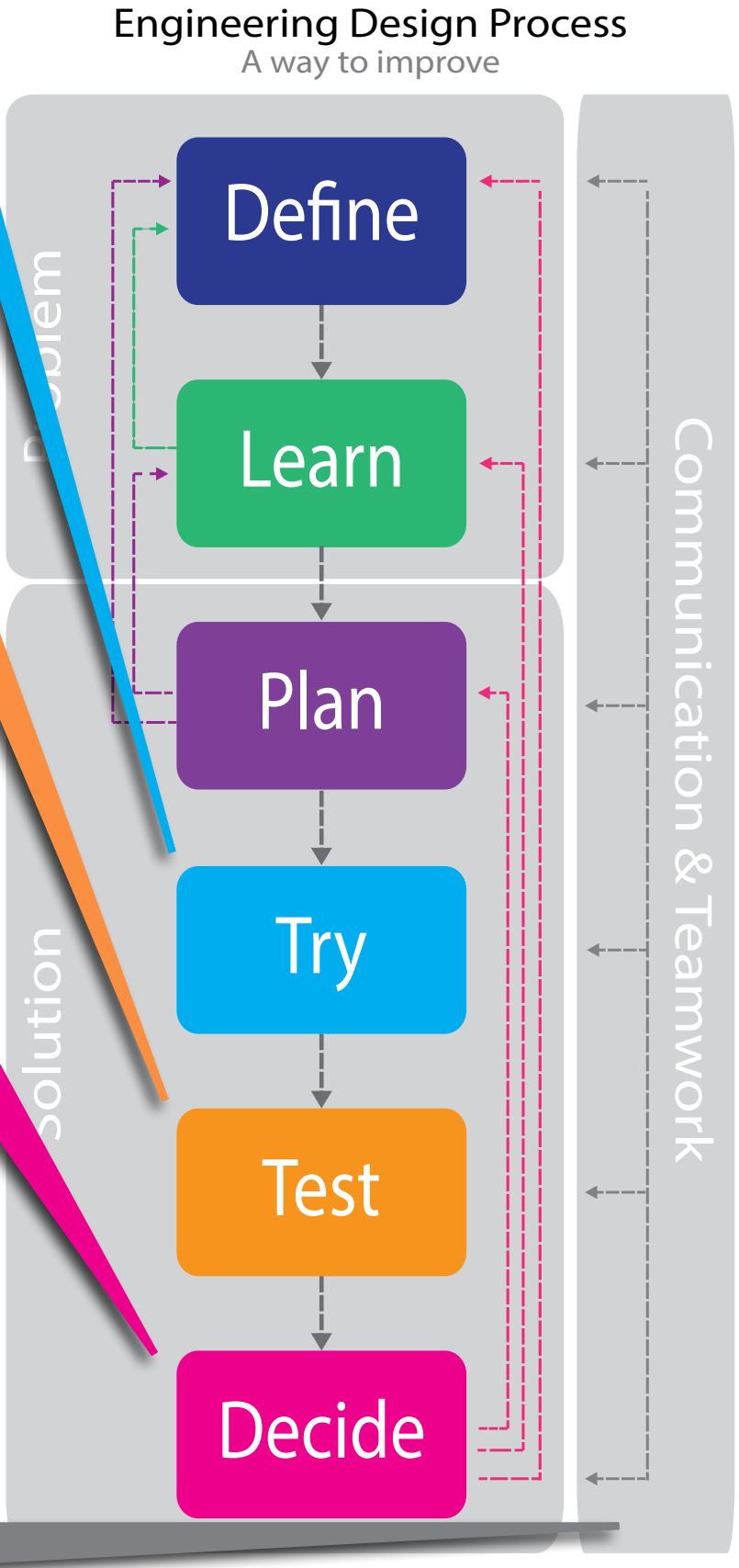
### DECIDE IF THE SOLUTION IS GOOD ENOUGH

- Are users able to use the design to help with the problem?
- Does the design meet the criteria?
- How could the design be improved based on test results and feedback from the client/user?

**Iterative nature of design:** Always consider which step should be next!

### TEAMWORK

- Discuss in teams how the solution meets the criteria and needs of the client
- Consider different viewpoints from each teammate



# Overview: Unit Description

## Grade Levels

K-2

## Approximate Time Needed to Complete Unit (see unit overview for breakdown)

Introduction: one 45 minute class period
Literacy: six 25-40 minute class periods
STEM+C: six 40-60 minute class periods

## Unit Summary

Max and Lola want to give people who visit their rock collection a basket to collect their own rocks; however, they will not be able to make enough for everyone. In this unit, students explore patterns and investigate the strength and properties of paper before applying them to design a paper basket.

| Science Connections | Technology & Engineering Connections | Mathematics Connections |
|---|---|---|
| Investigate properties of paper and water, test paper strength, conduct fair tests | Create a basket design plan, follow the engineering design process | Identify and create patterns, count and write numbers up to 50 |

## Standards Alignment

### Next Generation Science Standard

- **K-2-ETS1-1:** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
- **K-2-ETS1-2:** Develop a simple sketch, drawing or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- **K-2-ETS1-3:** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
- **Practice 1:** Asking questions and defining problems
- **Practice 2:** Developing and using models
- **Practice 3:** Planning and carrying out investigations
- **Practice 4:** Analyzing and interpreting data
- **Practice 8:** Obtaining, evaluating, and communicating information

### Common Core State Standards - Mathematics

- **K.CC.A.3:** Write numbers from 0 to 20. Represent a number of objects with a written numeral 0-20 (with 0 representing a count of no objects).
- **K.CC.B.4:** Understand the relationship between numbers and quantities; connect counting to cardinality.
- **K.CC.B.5:** Count to answer "how many?" questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1-20, count out that many objects.
- **K.CC.C.6:** Identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group, e.g., by using matching and counting strategies.
- **MP1:** Make sense of problems and persevere in solving them.
- **MP6:** Attend to precision.

## Common Core State Standards - English/Language Arts

- **RL.K.1:** With prompting and support, ask and answer questions about key details in a text.
- **RL.K.2:** With prompting and support, retell familiar stories, including key details.
- **RL.K.3:** With prompting and support, identify characters, settings, and major events in a story.
- **RL.K.5:** Recognize common types of texts (e.g., storybooks, poems).
- **RL.K.7:** With prompting and support, describe the relationship between illustrations and the story in which they appear (e.g., what moment in a story an illustration depicts).
- **RL.K.9:** With prompting and support, compare and contrast the adventures and experiences of characters in familiar stories.
- **RL.K.10:** Actively engage in group reading activities with purpose and understanding.
- **RI.K.1:** With prompting and support, ask and answer questions about key details in a text.
- **RI.K.10:** Actively engage in group reading activities with purpose and understanding.
- **RF.K.2:** Demonstrate understanding of spoken words, syllables, and sounds (phonemes).
- **RF.K.2.A:** Recognize and produce rhyming words.
- **RF.K.2.B:** Count, pronounce, blend, and segment syllables in spoken words.
- **RF.K.2.C:** Blend and segment onsets and rimes of single-syllable spoken words.
- **RF.K.2.D:** Isolate and pronounce the initial, medial vowel, and final sounds (phonemes) in three-phoneme (consonant-vowel-consonant, or CVC) words. (This does not include CVCs ending with /l/, /r/, or /x/.)
- **RF.K.2.E:** Add or substitute individual sounds (phonemes) in simple, one-syllable words to make new words.
- **W.K.2:** Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.
- **W.K.3:** Use a combination of drawing, dictating, and writing to narrate a single event or several loosely linked events, tell about the events in the order in which they occurred, and provide a reaction to what happened.
- **SL.K.1:** Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups.
- **SL.K.2:** Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.
- **SL.K.6:** Speak audibly and express thoughts, feelings, and ideas clearly.
- **L.K.1.A:** Print many upper- and lowercase letters.
- **L.K.1.F:** Produce and expand complete sentences in shared language activities.

## CSTA Standards

- **1A-A-5-3:** Plan and create a design document to illustrate thoughts, ideas, and stories in a sequential (step-by-step) manner (e.g., story map, storyboard, sequential graphic organizer).
- **1A-A-4-4:** Use numbers or other symbols to represent data (e.g., thumbs up/down for yes/no, color by number, arrows for direction, encoding/decoding a word using numbers or pictographs).
- **1A-A-3-5:** Decompose (break down) a larger problem into smaller sub-problems with teacher guidance or independently.
- **1A-A-3-6:** Categorize a group of items based on the attributes or actions of each item, with or without a computing device.
- **1A-A-6-8:** Analyze and debug (fix) an algorithm that includes sequencing and simple loops, with or without a computing device.

# Overview: Unit Description

## Standards Alignment - Indiana Standards

### Science Standards

- **SEPS.1:** Posing questions (for science) and defining problems (for engineering).
- **SEPS.2:** Developing and using models and tools.
- **SEPS.3:** Constructing and performing investigations.
- **SEPS.4:** Analyzing and interpreting data.
- **SEPS.5:** Using mathematics and computational thinking.
- **SEPS.6:** Constructing explanations (for science) and designing solutions (for engineering).
- **SEPS.8:** Obtaining, evaluating, and communicating information.
- **K.PS.1:** Plan and conduct an investigation using all senses to describe and classify different kinds of objects by their composition and physical properties. Explain these choices to others and generate questions about the objects.
- **K.PS.2:** Identify and explain possible uses for an object based on its properties and compare these uses with other students' ideas.
- **K-2.E.1:** Pose questions, make observations, and obtain information about a situation people want to change. Use this data to define a simple problem that can be solved through the construction of a new or improved object or tool.
- **K-2.E.2:** Develop a simple sketch, drawing, or physical model to illustrate and investigate how the shape of an object helps it function as needed to solve an identified problem.
- **K-2.E.3:** Analyze data from the investigation of two objects constructed to solve the same problem to compare the strengths and weaknesses of how each performs.

### Mathematics Standards

- **K.NS.2:** Write whole numbers from 0 to 20 and recognize number words from 0 to 10. Represent a number of objects with a written numeral 0-20 (with 0 representing a count of no objects).
- **K.NS.4:** Say the number names in standard order when counting objects, pairing each object with one and only one number name and each number name with one and only one object. Understand that the last number name said describes the number of objects counted and that the number of objects is the same regardless of their arrangement or the order in which they were counted.
- **K.NS.5:** Count up to 20 objects arranged in a line, a rectangular array, or a circle. Count up to 10 objects in a scattered configuration. Count out the number of objects, given a number from 1 to 20.
- **K.CA.5:** Create, extend, and give an appropriate rule for simple repeating and growing patterns with numbers and shapes.

### English/Language Arts Standards

- **K.SL.2.1:** Participate in collaborative conversations about grade appropriate topics and texts with peers and adults in small and larger groups.
- **K.SL.2.3:** Listen to others, take turns speaking, and add one's own ideas to small group discussions or tasks.
- **K.SL.2.4:** Ask questions to seek help, get information, or clarify something that is not understood.
- **K.SL.2.5:** Continue a conversation through multiple exchanges.
- **K.SL.3.1:** Ask and answer questions about key details in a text read aloud or information presented orally or through other media.
- **K.SL.4.3:** Give, restate, and follow simple two step directions.
- **K.W.1:** Write for a specific purpose and audiences.
- **K.W.2.1:** Write most uppercase (capital) and lowercase letters of the alphabet, correctly shaping and spacing the letters of the words.
- **K.W.2.2:** Write by moving from left to right and top to bottom.

## Standards Alignment - Indiana Standards

### English/Language Arts Standards

- **K.W.3.2:** Use words and pictures to develop a main idea and provide some information about a topic.
- **K.W.3.3:** Use words and picture to narrate a single event or simple story, arranging ideas in order.
- **K.W.6.2a:** Capitalization-Capitalizing the first word in a sentence and the pronoun I.
- **K.W.6.2b:** Punctuation- Recognizing and naming end punctuation.
- **K.W.6.2c:** Spelling- Spelling simple words phonetically, drawing on phonemic awareness.
- **K.RV.1:** Use words, phrases, and strategies acquired through conversations, reading and being read to, and responding to literature and nonfiction texts to build and apply vocabulary.
- **K.RN.1:** Actively engage in group reading activities with purpose and understanding.
- **K.RN.2.1:** With support, ask and answer questions about important elements of a text (e.g., events, topics, concepts).
- **K.RL.2.1:** With support, ask and answer questions about main topics and key details in a text heard or read.
- **K.RL.2.3:** Identify important elements of the text (e.g., characters, settings, or events).
- **K.RL.4.2:** With support, compare and contrast the adventures and experiences of characters in familiar stories.
- **K.RF.2.1:** Demonstrate understanding that print moves from left to right across the page and from top to bottom.
- **K.RF.2.2:** Recognize that written words are made up of sequences of letters.
- **K.RF.2.3:** Recognize that words are combined to form sentences.
- **K.RF.3.1:** Identify and produce rhyming words.
- **K.RF.3.2:** Orally pronounce, blend, and segment words into syllables.
- **K.RF.3.3:** Orally blend the onset (the initial sound) and the rime (the vowel and ending sound) in words.
- **K.RF.3.4:** Tell the order of sounds heard in words with two or three phonemes, and identify the beginning, middle (medial) and final sounds.
- **K.RF.3.5:** Add, delete, or substitute sounds to change words.

### Computer Science Standards

- **K-2.DI-2:** Understand how to arrange (sort) information into useful order, such as sorting students by birth date, without using a computer.

# Overview: Lesson Summaries

**Introduction - Define the Problem:** In this introductory lesson, students are introduced to the problem through email interactions with their clients, Max and Lola. They have the opportunity to explore the engineering design process, ask questions of their client, help their client define the problem to be solved, and identify the criteria of the problem to be solved.

**Lesson 1A - If You Find a Rock:** In this literacy lesson, students are introduced to rock collecting and why collecting rocks can be fun and interesting by reading, *If You Find a Rock* by Peggy Christian – a poem with pictures that match the text. The focus for this lesson is looking at how rocks are different and how they can be categorized by size, color, or use (for example, chalk rock, big, mossy rock, wishing rock). This leads into the idea that rocks are something that can be collected, which sets the context for the engineering design challenge in which they have to design a paper basket that can carry wet and dry rocks. Reading strategy: identifying beginning and ending sounds.

**Lesson 1B - Paper Properties:** In this STEM+C lesson, students identify the observable properties of paper samples and sort the various samples using those observable properties through selected readings within *Be a Friend to Trees* by Patricia Lauber and hands-on explorations of paper types. This lesson builds background knowledge for the engineering design challenge by introducing students to the types and properties of the papers that they will be able to use for their paper basket.

**Lesson 2A - I Get Wet (Part 1):** In this literacy lesson, students learn about the properties of water through the first part of the book, *I Get Wet* by Vikki Cobb - a nonfiction science text. Students build skills to help with the development of phonemic awareness by identifying the letters representing sounds from the story. As students are writing the letters of three phoneme words in sounds boxes, they are also learning about water and some of the properties of water. In the previous lesson, students learned about the observable properties of the papers they would be using, and this lesson not only builds background knowledge about water, but also sets the context for lesson 2B. Since this is a longer nonfiction book, this lesson only goes up through the first part of the book, where the question, what happens when you place a drop of water on wax paper, is posed in the book and then explored in the related STEM+C lesson (2B). Reading strategy: blending three phoneme words.

**Lesson 2B - Investigating Paper and Water:** In this STEM+C lesson, students investigate what happens when water drops are placed on different types of papers by conducting a water drop test on regular, wax, and wax-coated paper. This lesson helps familiarize students with wax paper, which is a less familiar paper, and how wax and copy paper are affected by water. While, the wax paper is not as strong as copy paper when dry, it holds up better when wet. This is an important step for students as it starts to introduce some of the trade-offs that come with the final design challenge of needing to carry both wet and dry rocks.

**Lesson 3A - I Get Wet (Part 2):** In this literacy lesson, students continue to build their reading skills by interactively creating a summary sentence about the text, *I Get Wet* by Vikki Cobb. This second part of the book picks up where they left off in Lesson 2A, by providing an answer to the question about water and wax paper that was investigated in Lesson 2B. Reading strategy: summarizing informational text.

**Lesson 3B - Investigating Paper Strength:** In this STEM+C lesson, students build upon their knowledge and understanding of the different properties of paper to start to form predictions about how well these papers will carry rocks. After making predictions about the different types of paper and how they will perform when dry and wet, students use rocks to test the strength of these different papers when wet and when dry. Students then sort the papers based on their strength when wet and when dry and connect to the design challenge, by sharing ideas about which papers might be better (or worse) for their paper basket designs.

**Lesson 4A - Pattern Fish:** In this literacy lesson, students are introduced to patterns from a book called *Pattern Fish* by Trudy Harris. The students explore rhyme through the poetry in the book. Students will also connect the idea of patterns to the weaving in baskets, as they are presented with different types of weaving patterns that can be used in their final basket designs. This lesson helps students to work on the mathematics concept of pattern recognition by asking students to generate the next item in a pattern through spoken words, colors, and letters. Students also begin to work on abstraction of patterns by assigning letters to repeating patterns. Reading strategy: exploring rhyme.

**Lesson 4B - Patterns in Weaving:** In this STEM+C lesson, students continue to build on the work they did with patterns in the literacy lesson, 4A, as they look at four different patterns that can be used in their final basket designs. The focus of this lesson is on weaving and alternating patterns as they work to understand why alternating patterns are important to the strength of their baskets. After exploring these four different patterns, as a class they complete a simulation of testing dry rocks with the different patterns before moving into a discussion of why certain patterns are stronger or weaker.

**Lesson 5A - The Most Magnificent Thing:** In this literacy lesson, students practice high level talk about text as they learn about a girl who overcomes failure to create the perfect thing for her and her bulldog sidekick by reading *The Most Magnificent Thing* by Ashley Spires. After reading the story, students will practice making connections between what they are reading and their own lives as they work on increasing their comprehension of texts. The focus on failure and perseverance are important reminders for students as this lesson starts to transition from building background knowledge needed for their design into actually planning and working on their basket designs. Additionally, this lesson helps students to understand that sometimes we have good ideas in our head that can be difficult to get out on paper. Reading strategy: making connections.

**Lesson 5B - Designing Baskets:** In this STEM+C lesson, students will identify the errors in different weaving patterns as they work on their debugging skills before using what they learned about patterns from Lesson 4A and 4B to decide which pattern to use in their own designs. Students will also use what they learned about the properties of paper (Lesson 1B & 2B) and paper strength (Lesson 3B) to make decisions about which papers to use in their basket design.

**Lesson 6A - Rocks, Jeans, and Busy Machines:** In this literacy lesson, students will learn about what engineers do and a field of engineering, construction engineering, as they continue to work through the engineering design process with their basket design. The focus of this lesson is on summarizing narrative text by engaging in interactive sentence writing to identify the beginning, middle and end of a fictional story, *Rocks, Jeans, and Busy Machines: An Engineering Kids Storybook* by Alane and Raymundo Rivera. Reading strategy: summarizing narrative text.

**Lesson 6B - Testing Baskets:** In this STEM+C lesson, students will continue to work through the engineering design process as they test the paper baskets that they created in Lesson 5B. An important part of the engineering design process is finding out when their designs work AND when they don't work, and so it is important for students to have a chance to test their baskets when wet and when dry, before reflecting, redesigning and retesting their baskets. After testing has been completed, students will use what they learned and work on their communication skills to write letters to Max and Lola, making recommendations for their basket design.

# Overview: Unit Overview

| Lesson | Activity Type | Time Needed | Materials |
|---|---|---|---|
| Introduction | STEM | 45 minutes | • **Per student:** Engineering Design Process Slider, paper clip (used during the whole unit)<br>• **Per class:** Chart paper, markers (used during the whole unit), copies of Max's emails, Engineering Design Process Slider Poster & paper clip (used during the whole unit), Velcro |
| 1A: If You Find A Rock | Literacy | 25 minutes | • **Per student:** Identifying Beginning and Ending Sounds worksheet<br>• **Per class:** *If You Find a Rock,* rocks to sort |
| 1B: Paper Properties | STEM | 40 minutes | • **Per student:** (1) 4"x4" square of copy paper, Paper Properties data collection sheet<br>• **Per pair:** Bag with (1) 4"x4" square of the following: construction paper, paper towel, tissue paper, and wax paper<br>• **Per class:** *Be a Friend to Trees,* (5) chart paper, Max's second letter |
| 2A: I Get Wet - Part 1 | Literacy | 30 minutes | • **Per student:** Sound Boxes sheet<br>• **Per class:** *I Get Wet,* large copy or projection of the Sound Boxes handout |
| 2B: Investigating Paper & Water | STEM | 50 minutes | • **Per student:** White crayon, Water Drop Test Observation sheet<br>• **Per pair:** (1) 4"x4" square of copy paper, (1) 4"x4" square of wax paper, (1) eyedropper or pipette, (1) plastic cup, bag of paper samples from lesson 1B (optional)<br>• **Per class:** *I Get Wet,* (1) food coloring, timer, Paper Properties Charts, pitcher of water or water source |
| 3A: I Get Wet - Part 2 | Literacy | 30 minutes | • **Per student:** Summary Worksheet<br>• **Per class:** *I Get Wet* |
| 3B: Investigating Paper Strength | STEM | 50 minutes | • **Per student:** Investigating Paper Strength data collection sheets<br>• **Per class:** 8.5"x11" sheets of the following: copy paper, construction paper, tissue paper, waxed paper, paper towel; Paper Properties Charts; (1) tub; (20) medium-sized rocks (river rocks), (1) cup of water, (1) eyedropper or pipette, (1) test station, extra paper towels |
| 4A: Pattern Fish | Literacy + CT | 35 minutes | • **Per student:** *Pattern Fish - Patterns* worksheet, crayons (red, yellow, and green)<br>• **Per class:** *Pattern Fish,* images of woven baskets<br>• **Optional:** *Pattern Fish - Rhyme Assessment* (1 per student) |
| 4B: Patterns in Weaving | STEM + CT | 45 minutes | • **Per student:** *Weaving Patterns* worksheet<br>• **Per class:** (1) set of 20 rocks, (1) large tub, (1 each type) construction paper version of the *Pattern Weaving Examples* |

| Objectives<br>The student will be able to: |
| --- |
| • **Engineering:** ask questions and gather information to define a problem about a situation people want to change through developing a new tool. |
| • **Literacy:** identify beginning and ending sounds of words.<br>• **Science:** identify ways rocks can be sorted to make a collection. |
| • **Science:** identify properties of paper samples and sort using those properties.<br>• **Engineering**: determine which papers have properties best suited for an intended purpose. |
| • **Literacy:** point to, say, and blend three letters in sound boxes that represent the phonemes of a word.<br>• **Literacy and Science:** discuss the text being read and answer questions about water. |
| • **Science:** investigate that properties are characteristics of something.<br>• **Engineering:** ask questions, make observations, and gather information to define a problem about a situation people want to change through developing a new tool. |
| • **Literacy:** discuss the text they are reading and answer questions about what they learned about water.<br>• **Literacy:** summarize the text as a class using interactive writing. |
| • **Science:** describe that the strength of the paper is dependent on the properties of the paper.<br>• **Engineering:** ask questions, make observations, and gather information to define a problem about a situation people want to change through developing a new tool. |
| • **Literacy:** discuss what makes some literature poetry.<br>  • generate a rhyming and non-rhyming word for a given keyword.<br>  • generate pairs of rhyming words.<br>  • recognize rhyming words in the story.<br>• **Mathematics:** generate the next item in a pattern through spoken words, colors, letters. Begin to work on abstraction of patterns by assigning letters to repeating patterns.<br>• **Computational Thinking:** *Problem Decomposition* - break down tasks into smaller, manageable parts. Pattern *Recognition* - describe how different patterns repeat and alternate. |
| • **Science:** use a model to illustrate how the shape of an object helps it function as needed to solve a given problem.<br>• **Engineering:** investigate how the woven pattern changes the strength.<br>• **Mathematics:** recognize and identify patterns (focus on identification and abstraction to letters)<br>• **Computational Thinking - Pattern Recognition:** explore how different patterns repeat and alternate in basket designs. |

# Overview: Unit Overview

| Lesson | Activity Type | Time Needed | Materials |
|---|---|---|---|
| 5A: The Most Magnificent Thing | Literacy | 40 minutes | • **Per student:** *Making Connections* graphic organizer<br>• **Per class:** *The Most Magnificent Thing,* chart paper |
| 5B: Designing Baskets | STEM + CT | 50 minutes | • **Per student:** *Basket Design Plan* sheet<br>• **Per pair:** paper basket template, yarn<br>• **Per class:** *Pattern Debugging* images, (~90 each kind) paper strips for weaving (construction paper, copy paper, waxed paper, tissue paper, paper towel), 3 rolls of cellophane tape |
| 6A: Rocks, Jeans, & Busy Machines | Literacy | 40 minutes | • **Per student:** *Summary Worksheet Beginning*, *Summary Worksheet Middle*, & *Summary Worksheet End*<br>• **Per class:** *Rocks, Jeans, and Busy Machines*, chart paper |
| 6B: Testing Baskets | STEM | 60 minutes | • **Per student:** (2) **Prototype #___ Basket Design Plan** sheets<br>• **Per pair:** basket prototypes from 5B, *Final Letter to Max and Lola*, glue stick<br>• **Per class:** second email from Max (intro lesson), (2) testing stations: large plastic tub, cup of water, eyedropper OR pipette, and bag of 50+ medium-sized rocks (river rocks) for testing, chart paper, Thank you email from Max and Lola<br>• **For redesign**: all materials from 5B and 6B |

| Objectives<br>The student will be able to: |
| --- |
| • **Literacy:** engage in high level talk about a text, make connections between the story and their own lives.<br>• **Engineering:** recognize that failure and perseverance are needed if the basket fails. |
| • **Mathematics:** apply what they have learned about alternating patterns and strength to their designs.<br>• **Science:** use a model to illustrate how the shape of an object helps it function as needed to solve a given problem.<br>• **Engineering:** develop a simple model based on evidence to represent a proposed tool.<br>• **Computational Thinking:** Debugging/Pattern Recognition - identify errors in the repetition of simple patterns. |
| • **Literacy:** summarize narrative text by engaging in interactive sentence writing to identify the beginning, middle and end of the story.<br>• **Literacy:** observe teacher reading from left to right.<br>• **Literacy:** understand engineering words and definitions of the words. |
| • **Science:** conduct investigations to understand how things work.<br>• **Engineering:** gather data from tests of an object or tool that can be analyzed to determine if it works as intended. |

# Master Materials List

**KEY**
**(#S): Number of students**
**(#P): Number of pairs**
**(L): Laminate**

- 6 books
  - *If You Find a Rock* by Peggy Christian
  - *Be a Friend To Trees* by Patricia Lauber
  - *I Get Wet* by Vikki Cobb
  - *Pattern Fish* by Trudy Harris
  - *The Most Magnificent Thing* by Ashley Spires
  - *Rocks, Jeans, and Busy Machines* by Alane and Raymundo Rivera
- chart paper pack (1)
- pack of chart paper markers (1)
- jumbo paper clips (#S)
- white Velcro sticky back strips (5'x ¾" works well)
- quart storage baggies (#P)
- 4"x4" square of copy paper (#S + 1 for Paper Properties Chart [Lesson 1B] + #P [Lesson 2B])
- 4"x4" square of wax paper (#P+ 1 for Paper Properties Chart [Lesson 1B] + #P [Lesson 2B])
- 4"x4" square of construction paper (#P + 1 for Paper Properties Chart [Lesson 1B])
- 4"x4" square of paper towel (#P + 1 for Paper Properties Chart [Lesson 1B])
- 4"x4" square of tissue paper (#P + 1 for Paper Properties Chart [Lesson 1B])
- 100+ medium-sized smooth rocks (river rocks work well - see front cover)
- cups (approx. 9 oz.) (#P)
- blue food coloring (1)
- plastic transfer pipettes (or eye droppers) (#P)
- crayons: white, red, yellow, green (#S)
- plastic tubs (2) (e.g., 12 qt. dishpan tubs)
- full size (at least 8½"x11") (1 each):
  - paper towel
  - tissue paper
  - copy paper
  - construction paper
  - wax paper
- construction paper versions of Pattern Weaving Examples ABAB, AABB, AABAAB, & ABAB [not alternating] (1 of each type)
- rolls of cellophane tape (3)
- 39" strings of yarn (#P x 2)
- 8½"x1" wide strips:
  - ~90 copy paper
  - ~90 tissue paper
  - ~90 paper towel
  - ~90 construction paper
  - ~90 wax paper
- glue stick (#P)

# Master Printing List

**KEY**
**(#S): Number of students**
**(#P): Number of pairs**
**(L): Laminate**

**Printable Manipulatives and Reusable Educator Resources**

- large Engineering Design Process slider poster and large paper clip (L)
- Engineering Design Process slider (#S, L)
- First Email from Max (L)
- Second Email from Max (L)
- Basket Image 1 (L)
- Basket Image 2 (L)
- basket templates (#P x 2)
- Pattern Debugging ABAB, AABB, AABAAB, & ABAB [not alternating] (1 each, L)
- Thank You Email from Max and Lola (L)

**Student Handouts and Educator Resources**

- Identifying Beginning and Ending Sounds worksheet
- Investigating Paper Properties data collection sheet
- Sound Boxes sheet
- Water Drop Test Observation Sheet
- Summary Worksheet
- Investigating Paper Strength: Dry Paper Test data collection sheet
- Investigating Paper Strength: Wet Paper Test data collection sheet
- Pattern Fish - Patterns worksheet
- Optional: Pattern Fish - Rhyme Assessment (Educator Resource)
- Weaving Patterns worksheet
- Making Connections graphic organizer
- Basket Design Plan
- Summary Worksheet (Beginning, Middle, End)
- Prototype #_ Basket Design Plan
- Final Letter to Max and Lola

Lesson Intro

**FOCUS/KEY CONCEPTS**

Students will be able to:

- **Engineering:** ask questions and gather information to define a problem about a situation people want to change through developing a new tool.

**STANDARDS**

- CCSS - ELA: SL.K.1, SL.K.2, SL.K.6
- NGSS: K-2-ETS1-1, P1
- CCSS - Math: MP1

**MATERIALS**

- **Per student: Engineering Design Process Slider**, paper clip
- **Per class:** Chart paper, markers, copies of Max's emails, **Engineering Design Process Slider Poster** & paper clip, Velcro

**TEACHER PREPARATION**

- Prepare **Engineering Design Process Slider Poster** and individual sliders for each student (see educator resource for instructions)
- Write "Problem" and "Criteria" on chart paper

**VOCABULARY**

- **Basket** A container made of flexible materials woven together
- **Template** Something that serves as a model for others to copy
- **Engineer** A person who uses mathematics, science, and creativity to solve problems to help people
- **Criteria** Goals and limits of the design problem

(continued on next page)

# Defining the Problem

## SUMMARY OF THE PROBLEM

In this introductory lesson, students are introduced to the problem through email interactions with their clients, Max and Lola. They have the opportunity to explore the engineering design process, ask questions of their client, help their client define the problem to be solved, and identify the criteria of the problem to be solved.

## INTRODUCTION

1. **Introduce engineering.** **Say:** *We are going to be working as engineers over the next few days. Does anyone know what an engineer does?* Take student answers. **Say:** *Engineers are people who use science, mathematics, and creativity to solve problems to help people. Typically their solution is a new or improved technology or process.* **Ask:** *What problems do engineers solve?* Take student answers.

2. **Make a personal connection to engineering.** Give an example of a problem that you have had and ask students to help you think of a solution. Then ask students to share a problem they might have or have had in the past. **Say:** *Those are some good problems, and just like that you are starting to think like engineers.*

3. **Make a personal connection to the challenge.** **Ask:** *Have you ever tried to carry so many things that you were not able to do it with just your hands? What did you do to solve that problem?* Allow students to share their experiences.

4. **Introduce the engineering design process.** Display the **Engineering Design Process Slider Poster** and have students place their engineering design cycle slider in front of them. NOTE: If this is a distraction, only use the poster. Explain that engineers use this process along with science, mathematics, and creativity to understand a problem and create a solution.
   - **DEFINE:** Engineers must define the problem and criteria (goals and limits).
   - **LEARN:** To better understand the problem engineers must learn about the science and other factors that impact how the problem can be solved. As they learn, they must keep the problem and its goals and limits in mind.
   - **PLAN:** Engineers brainstorm many ideas before deciding which one to try. They must make plans that clearly communicate their idea. Plans may include some of the following information in word and/or picture form: measurements, materials, colors, how things fit together and the order in which things should be done. Engineers must make sure that their plan meets the goals and limits presented in the problem as best as possible. While creating their plan engineers may find they need to go back and learn something before their plan can be finalized.
   - **TRY:** Engineers use their plan to try to create a prototype of their planned solution. A prototype is testable model used to test a design plan. Although a prototype allows the engineer to test parts of their design, it is not the final solution or product. In fact, it may not even be the same size as the final design.
   - **TEST:** Engineers test their plan to see if it is a good solution for the problem. Engineers must conduct fair tests and use mathematics to make sense of the data they collect.
   - **DECIDE:** Engineers use the test results to make decisions about the solution. Does it solve the problem and meet the criteria (goals and limits)? Are there new things that need to be learned in order to better solve the problem? Should they try other ideas that were previously brainstormed or brainstorm new ideas to achieve a better solution?

# Defining the Problem

5. **Introduce the engineering challenge.** Read the **Email from Max.**

6. **Identify where they are in the engineering design process. (Define)** Engineers need to define the problem they will solve before they can learn about the problem, plan a design, try the design, test the design, and decide if their design works.

## ACTIVITY - Defining the problem

7. **Provide feedback to Max and Lola.** **Say:** *Let's think back to the email we received from Max.* **Ask:** *Who needs something from us?* Max and Lola. (NOTE: Consider introducing the word "client" to the students.) **Ask:** *What is Max and Lola's problem? How can we help them?* They need to something to give away to help collect rocks. They want us to help them. **Ask:** *What are some of your ideas about things that Max and Lola can give away that will help others to collect rocks?* Record responses from students where they can see them. You may need to develop answers to the students' questions that help them focus in on the problem and not be distracted by other ideas. Pretend to send this information to Max via email and receive the following email back.
   NOTE: This would be a good time to take a break (give time for Max to 'respond'). This will also help break up the introduction.

8. **Define the problem.** Read the **Second Email from Max**. **Ask**: *What problem do Max and Lola need our help in solving?* Allow several students to respond. As a class create an agreed upon problem statement and record it on chart paper labeled "Problem."

9. **Define what an engineer is and what they do.** **Say:** *We are going to think like engineers while we work to design a basket template for Max and Lola.* Talk with students about what an engineer is and what they do. Engineers use mathematics, science, and creativity to solve problems to help people.

10. **Identify the criteria.** **Say:** *In his second email, Max said he and Lola want several things to be true about the basket. I'm going to read his email again, raise your hand when you hear something that Max wants to be true about the basket.* Read Max's letter aloud and record students' responses on chart paper labeled "Criteria." Examples: The basket should be able to carry lots of rocks. The basket should be able to carry wet and dry rocks. The basket should look nice.

    Point to the list and **say:** *Here is the list of things that need to be true about the basket design. They will help us know how well our designs meet Max and Lola's needs.* **Say:** *This list of things that you have said need to be true about the basket designs are called "criteria".* Define criteria as the goals of the design problem. Describe criteria as things that we use to decide how good a solution to the problem is.

## CLOSURE

11. **Check in with students.** Encourage students to share any questions they may have about the problem and criteria. Record their questions on a sheet of chart paper. Share that engineers also ask questions about the problems they are trying to solve to help them know what they need to learn more about and what kind of tests they must do before brainstorming a solution.

Lesson Intro

- **Engineering Design Process** A series of phases engineers go through in designing products such as background of a problem, designing and implementing a prototype, and evaluating and refining a designed product
- **Prototype** A testable model of a design

**TEACHER NOTES**


From: Max_the_collector@gmail.com
To: StudentEngineers@gmail.com
CC:
Subject: Rock Collecting Ideas (email #1)

Hi! My name is Max. I love to collect rocks with my friend Lola. We have a really amazing rock collection. Lola and I have found rocks from all over. Our favorite places to find rocks are the park and creek.

Lola and I are so excited. The local nature center wants us to set up a table next month to show off our rocks. We want to help others start their own rock collection by giving away something that will allow them to have as much fun collecting rocks as we have had.

Can you please send us some ideas about what we might give away to help others with their rock collecting?

Thank you for your help!

Max


Delete


Reply


Reply All


Forward


Move


Related


Follow Up

From: Max_the_collector@gmail.com
To: StudentEngineers@gmail.com
CC:
Subject: Re: Rock Collecting Ideas (email #2)

Dear Students,

Thank you for all your great ideas! We really liked them. In fact, they reminded Lola of the baskets they used to make when she lived in Kenya.

Lola and I will not be able to make enough baskets to give to everyone, but we could create a prototype to show them how to make their own.

Lola has a basket template that she used in Kenya, but the materials would cost too much. After looking around our houses, we think that the baskets could be created from paper. We just don't know what type would be strong enough to carry lots of rocks

We need the baskets to be able to carry rocks that are wet and dry. We would also like them to look nice. What kinds of paper can hold wet and dry rocks? What kinds of paper will make it look nice?

Lola and I need your help! Please investigate the different papers to find the best paper for our baskets. Use that paper along with Lola's basket template to create and test a prototype for us. When you have made any necessary improvements, please share your plan with us!

Thank you for your help!

Max

Lesson Intro

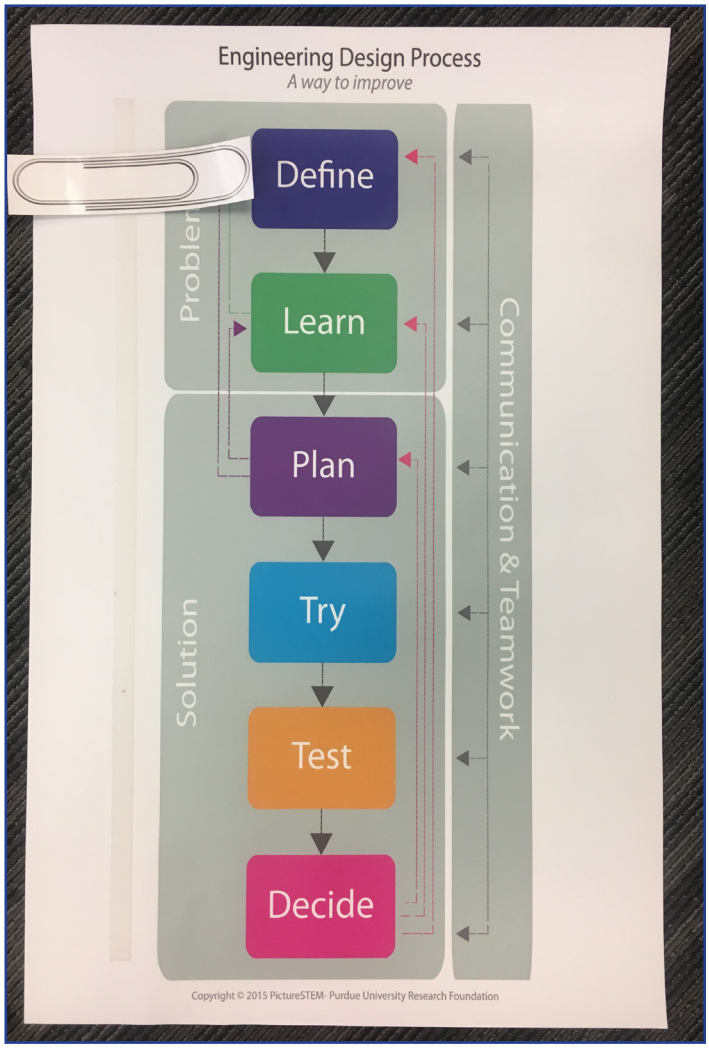
# How to make Engineering Design Process Sliders

## HOW TO CREATE THE POSTER

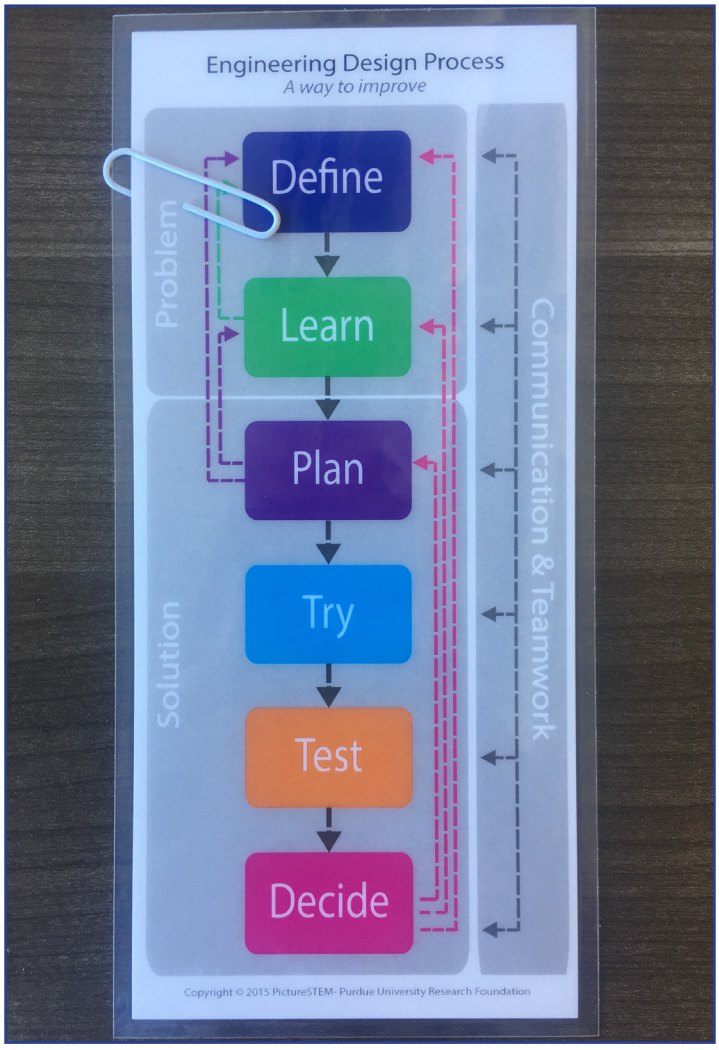
1. Download the high-quality PictureSTEM Slider Poster and the paper clip images from PictureSTEM.org.
2. Print the poster and the paper clip on poster sized paper and cut to size. High-gloss or semi-gloss paper is the best choice.
3. Use self-sticking Velcro on the back of the paper clip and down the side of the poster so that the paper clip can be placed to point at all 6 sections of the slider.

## HOW TO CREATE INDIVIDUAL SLIDERS

1. Print the sliders on the opposite page - enough for one slider per student in your class.
2. Cut the sliders apart.
3. Laminate the sliders individually.
4. Use a jumbo paper clip as the pointer for each slider.



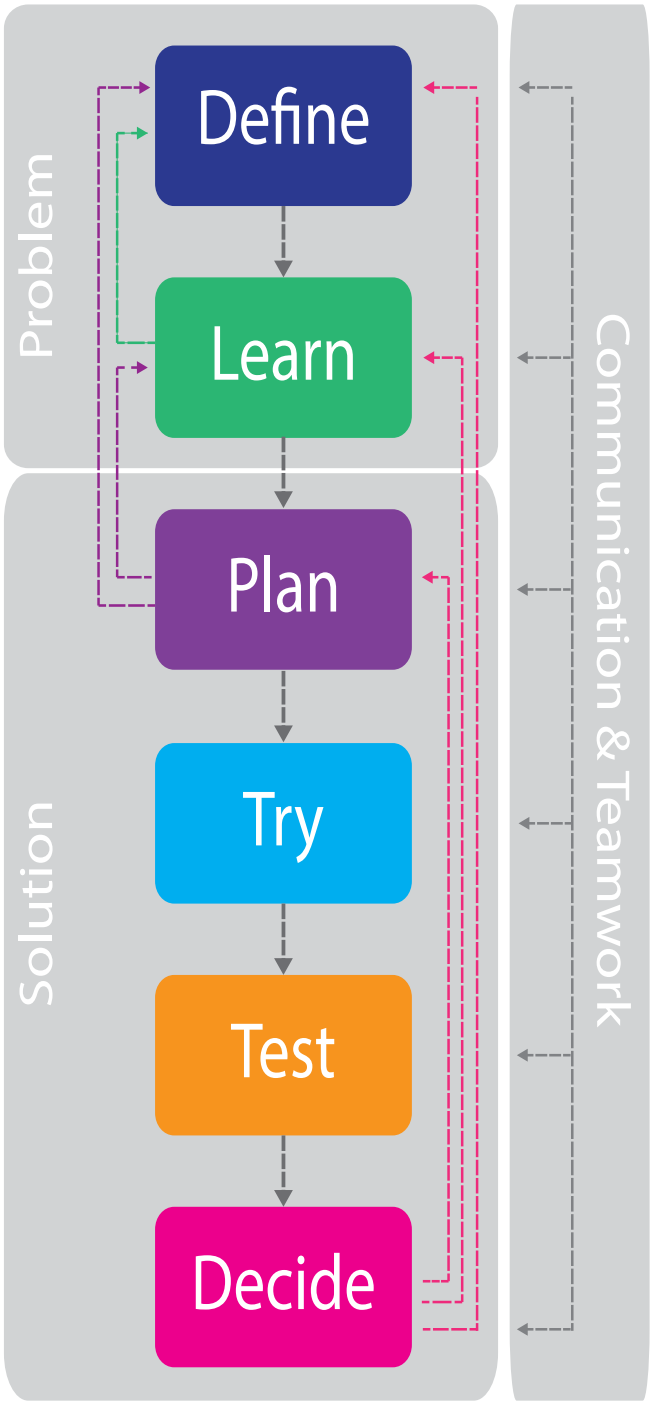

**Poster**




**Individual slider**

## Engineering Design Process

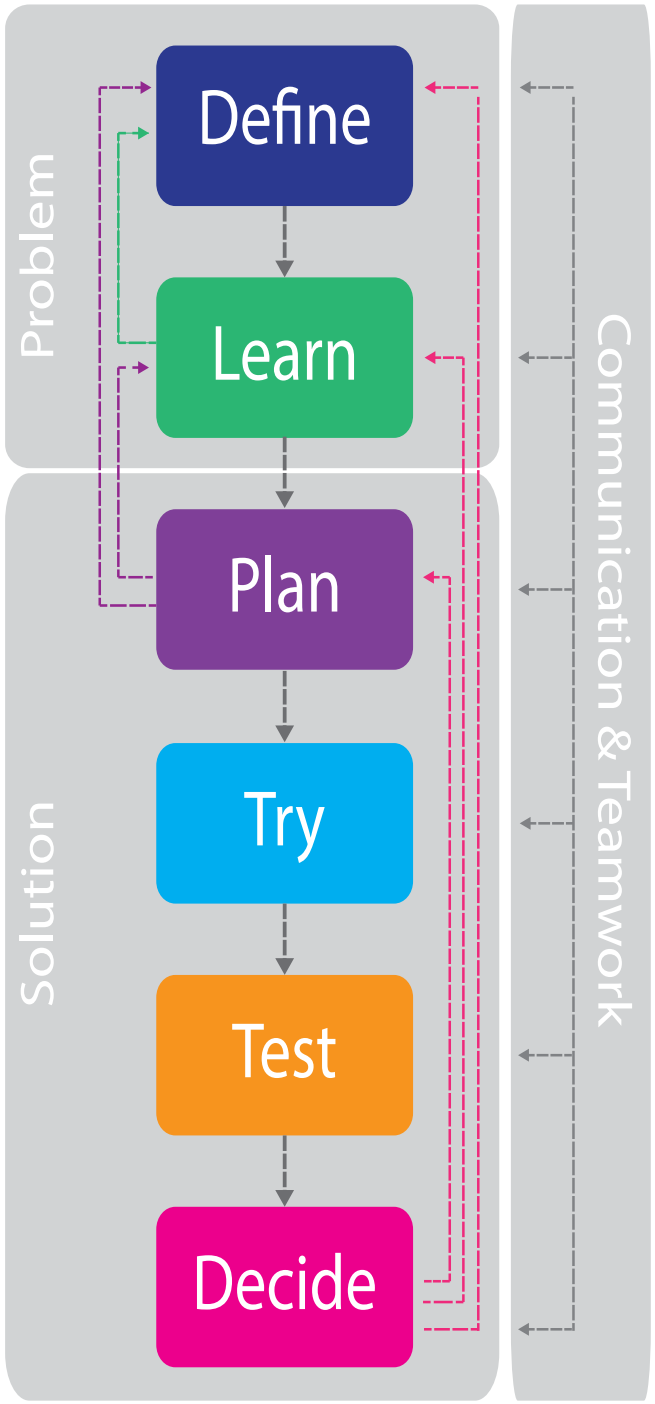
A way to improve






Engineering Design Process

A way to improve

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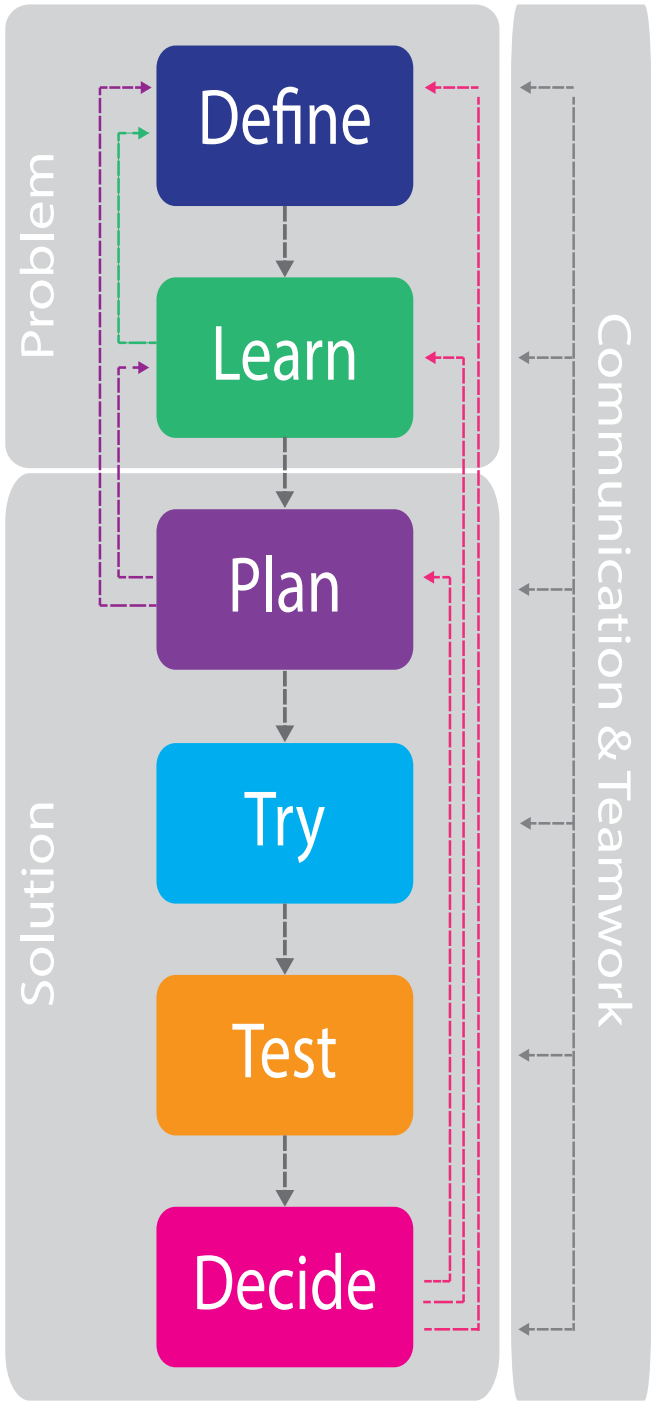
Engineering Design Process

A way to improve

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Lesson 1A

# If You Find A Rock

## SUMMARY OF THE PROBLEM

In this literacy lesson, students are introduced to rock collecting and why collecting rocks can be fun and interesting by reading *If You Find a Rock* by Peggy Christian – a poem with pictures that match the text. The focus for this lesson is looking at how rocks are different and how they can be categorized by size, color, or use (for example, chalk rock, big, mossy rock, wishing rock). This leads into the idea that rocks are something that can be collected, which sets the context for the engineering design challenge in which they have to design a paper basket template that can be used to make a basket that can carry wet and dry rocks. Reading strategy: identifying beginning and ending sounds.

## INTRODUCTION

1. **Discuss what makes a collection.** Have students share what they like to collect and why. *Examples of collections could be trading cards or stuffed animals*. Get students talking. Ask questions like: *What is your favorite thing to collect? Why did you choose to collect that item? How did you start collecting _____?*
   - Have students identify any collections in the classroom. Probe student understanding about what makes a collection. **Ask:** *Does everything in a collection have to look the same?*
   - To help tie back to the story and the purpose for reading, you could **say,** *As we are reading this book today, I want you to be thinking about these different rocks and some of the special properties that you could use to sort these rocks.*

2. **Tie to engineering challenge.** Max and Lola want to use paper to create their basket but are unsure about which papers to use. Students will learn about identifying properties of rocks that they can use later with paper.

3. **Identify where they are in the engineering design process. (Learn)** Remind students that an important part of the engineering design process is learning about the problem and ways to solve the problem. Engineers need to learn about classifying objects which will help them sort and identify properties of different paper later in the unit.

4. **Define collection.** After taking some initial student ideas on what can be collected have the students come up with a class definition of collection. Have students brainstorm on how rocks could be sorted to make a collection. Talk about sorting by size, color or how they feel (smooth, rough, heavy, etc.).

## ACTIVITY - Beginning and ending sounds

5. **Introduce the book**. Introduce students to *If You Find a Rock*, giving them some information about the key features of the book. (It is written as a poem with pictures that match the text on the opposite page as it tells the story of collecting rocks).

6. **Introduce the skill.** Introduce the target skill of identifying beginning and ending sounds to students. **Say:** *As we are reading today, we are going to be practicing with our sounds as we listen for the beginning and ending sounds of new words in the book. For example, here in the title is a word that we want to sound out, "if", what sound do we hear at the beginning of if?* (/ĭ/) **Ask**: *What do we hear at the end of if?* (/f/) **Ask:** *Are you ready to help me with this?*
   NOTE: It is important for the students to be able to hear and identify the beginning and ending sounds in a word to help with the development of their phonemic segmentation (hearing sounds in a word). Being able

**FOCUS/KEY CONCEPTS**

Students will be able to:

- **Literacy:** identify beginning and ending sounds of words.
- **Science:** identify ways rocks can be sorted to make a collection.

**STANDARDS**

- CCSS - ELA: RL.K.1, RL.K.10

**MATERIALS**

- **Per student: Identifying Beginning and Ending Sounds** worksheet
- **Per class:** *If You Find a Rock,* several types of rocks to sort

**TEACHER PREPARATION**

- Have a copy of the book, *If You Find a Rock*
- Prepare a copy of the **Identifying Beginning and Ending Sounds** worksheet for each student
- Collect some different types of rocks to sort
- Optional: If you have any collections in your classroom display them before you start this unit and refer to them during the lesson

**VOCABULARY**

- **Collection** A group of objects or an amount of materials accumulated in one location, especially for some purpose or as a result of some process
- **Find** Discover something unexpectedly
- **Moss** Tiny leafy stemmed flowerless plant
- **Rock** Solid mineral forming part of the surface of the Earth

to identify beginning and ending sounds is an important precursor to phonemic blending where students blend two and three phonemes together to come up with the word.

7. **Start reading and practice.** Start reading the story and pause when you come to the words listed below. Ask students to help you identify the beginning and ending sounds of common words that are used throughout the book.

   For example on Page 2 you would **say:** *Maybe you* (pause)*-here is our first word, listen carefully to the sound you hear at the beginning of find-/f/ind. What sound do you hear at the beginning of find?* **Ask:** *What sound do you hear at the end of find? Fin/d/, find.*

   Repeat the above with the following words:
   - Page 3: rock, beginning - /r/ock, ending – ro/k/
   - Page 6: big, beginning - /b/ig, ending – bi/g/
   - Page 7: way, beginning - /w/ay, ending – w/a/
   - Page 9: get, beginning - /g/et, ending ge/t/
   - Page 11: small, beginning -/s/mall, ending sma/l/
   - Page 14: hand, beginning - /h/ and, ending han/d/
   - Page 17: top, beginning - /t/op, ending to/p/

   While reading, use the following to guide the lesson development process:
   - Teach new vocabulary at the point of contact
   - Encourage higher - level thinking and comprehension monitoring by pausing for "teacher think alouds" and asking questions about text

8. **Individual practice.** Discuss the book and then have students complete the **Identifying Beginning and Ending Sounds** worksheet, and have the students use the worksheet to identify the pictures that begin with a particular sound.
   - Pictures that begin with the /f/ sound (as in find)
   - Pictures that end with the /d/sound (as in find)
   - Pictures that begin with the /r/sound (as in rock)
   - Pictures that end with the hard /ck/ sound (as in rock)

## CLOSURE

9. **Post reading.** To test students' understanding of the readings, **ask:** *Can you name the different rocks in the story? What was your favorite kind of rock from the book? This book was about collecting things, what is something that you would like to write a story about?*

10. **Tie back to the engineering challenge.** Help students connect what they learned in this lesson to the next lesson and the engineering challenge. **Ask:** *How could we sort the rocks into groups? In our engineering challenge, Max and Lola want to use paper to create their basket. Think about different types of paper. What might be a way we could sort paper into groups?*

## TEACHER NOTES

Lesson 1A

**ASSESSMENT**

**Pre-Activity Assessment**

Before the activity, ask students if they like to collect things by asking the questions, *What do you like to collect?* or *What collections do we have in our classroom?* To probe student understanding about rocks, you can ask students *Have you ever found a rock and kept it?* or *Where did you find the rock?*

**Activity Embedded Assessment**

Observe how students sorted the rocks. Ask questions about the rocks, such as how the rocks could be used, where rocks could be found, etc.

**Post-Activity Assessment**

Ask students the following questions to test their understanding of the readings :
- *Can you name the different rocks in the story?*
- *What was your favorite kind of rock from the book?*
- *Would you like to write a story about your favorite kind of rock?*

**EXTEND THE LESSON**
- Have the class write a short story about their favorite rock
- Have each student choose a memory rock and tell the class about a special memory the rock will remind them of each time they look at it
- Make a model rock collection for display in a nature center

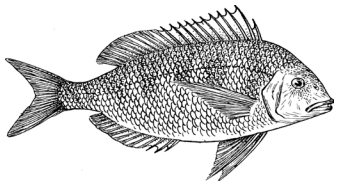
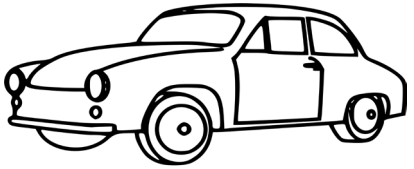
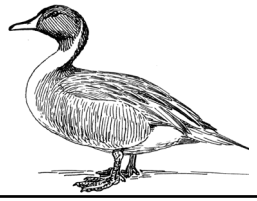
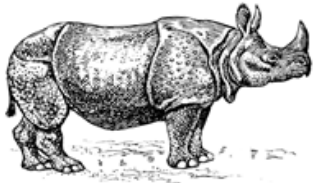
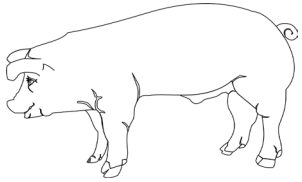
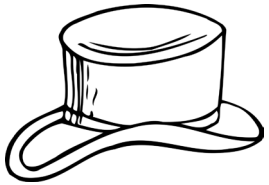
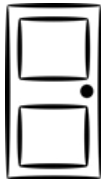
Lesson 1A

Name_____

# Identifying Beginning and Ending Sounds

## Beginning Sounds

**DIRECTIONS:** Circle the pictures that begin with the same letter sound.

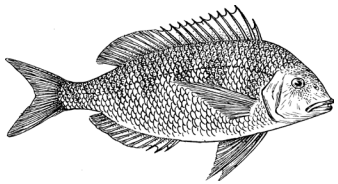
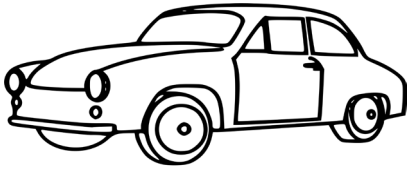
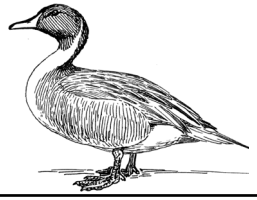
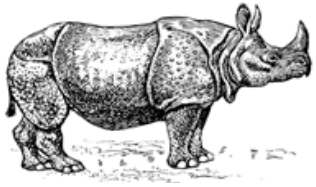
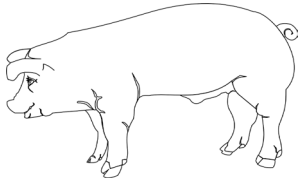
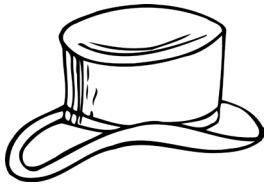
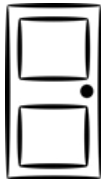
| | | | |
|---|---|---|---|
| **f**ind |  |  |  |
| **r**ock |  |  |  |
| **b**ig |  |  |  |
| **a**nt |  |  |  |
| **p**en |  |  |  |

Name_____

# Identifying Beginning and Ending Sounds

## Ending Sounds

**DIRECTIONS:** Circle the pictures that end with the same letter sound.

| | | | |
|---|---|---|---|
| fin**d** |  |  |  |
| ro**ck** |  |  |  |
| bi**g** |  |  |  |
| an**t** |  |  |  |
| pe**n** |  |  |  |

Lesson 1B

# Paper Properties

**FOCUS/KEY CONCEPTS**

Students will be able to:

- **Science:** identify properties of paper samples and sort using those properties.
- **Engineering**: determine which papers have properties best suited for an intended purpose.

**STANDARDS**

- CCSS - ELA: RL.K.7, RI.K.1, RI.K.10
- NGSS: K-2-EST1-1
- CSTA: 1A-A-3-6

**MATERIALS**

- **Per student:** (1) 4"x4" square of copy paper, **Investigating Paper Properties** data collection sheet
- **Per pair:** storage baggie with (1) 4"x4" square of the following: construction paper, paper towel, tissue paper, and wax paper
- **Per class:** *Be a Friend to Trees,* (5) chart paper, **Max's second email**

**TEACHER PREPARATION**

- Have a copy of the book *Be a Friend To Trees* by Patricia Lauber
- Prepare a copy of the **Investigating Paper Properties** data collection sheet (1/student)
- Prepare paper samples (1 copy paper sample for each student; 1 sample bag with the remaining 4 papers for each pair of students; 1 of each sample for Paper Properties Charts)
- Create Paper Properties Charts (step 4)

## SUMMARY OF THE PROBLEM

In this STEM+C lesson, students identify the observable properties of paper samples and sort the various samples using those observable properties through selected readings within *Be a Friend to Trees* by Patricia Lauber and hands-on explorations of paper types. This lesson builds background knowledge for the engineering design challenge by introducing students to the types and properties of the papers that they will be able to use for their paper basket.

## INTRODUCTION

1. **Start reading.** Read pages 1 – 8 in *Be a Friend to Trees* by Patricia Lauber. On chart paper or aloud create a list of things in the room that are made of wood.

   Read page 10 in *Be a Friend to Trees.* Create a list of things in the room made out of paper. Discuss how paper is made. Make sure to show students the picture on page 10 and emphasize that paper is made out of wood. Also have students talk about the purposes different papers serve.

2. **Tie to engineering challenge. Say:** *In Max's email, one of the criteria for the basket design is that we can only use the paper he and his friends have at home. They have construction paper, copy paper, waxed paper, tissue paper, and paper towel. Today we will investigate what properties or what characteristics each of these papers has.*

3. **Identify where they are in the engineering design process. (Learn)**
   **Ask:** *If we are going to work to understand these different papers, what step of the engineering design process do you think we are on?* Move paper clip to LEARN. Remind students that an important part of the engineering design process is learning about the problem and ways to solve the problem. Engineers need to learn about the materials they will use so they can make a design that meets the project criteria.

## ACTIVITY - Exploring properties of paper

4. **Set up the Paper Properties Charts.** Label each sheet of chart paper with a 4"x 4" paper sample and the corresponding paper name: "copy paper," "construction paper," "waxed paper," "tissue paper," and "paper towel."
   NOTE: These will be referred to as the Paper Properties Charts throughout the rest of the unit.

5. **Describe properties of paper.** Give each student a 4"x 4"square of copy paper. Ask students to describe the properties of the copy paper. Record their responses on a sheet of chart paper labeled "Copy Paper." Have students complete the the **Investigating Paper Properties** data collection sheet #1 with you as you write it on the chart. If appropriate, read the directions while students fill in the data collection sheet.
   NOTE: If you have not covered properties before, you will want to make sure to include question starters to help guide groups as they

work through the papers. (Is it soft? Smooth? Bumpy? Thick? Thin? Color?)

Divide students into pairs and give each group a bag of paper samples. Instruct students to talk to their partners about what they notice (the properties) of each of the remaining papers.

## CLOSURE

6. **Report and record observations.** Have groups report the properties of the papers. Record their observations on the corresponding Paper Properties Chart and post these with the "copy paper" chart completed earlier. Have students complete the rest of **Investigating Paper Properties** data collection sheet as you fill in the corresponding charts. If appropriate, read the directions while students fill in the data collection sheet.
   NOTE: For the "see through" test, you will want to decide as a class how you want to assess this property. The recommendation is to have the students put the paper on top of the data collection page and see if they can see the text through the paper. It also works to have them hold it up to their eye and see if they can see the lights through the paper.

7. **Make real world connections.** Lead a discussion on how the properties of each paper make it a good fit for its typical function. For example, construction paper is good for doing crafts because it is colorful and thicker than copy paper.

8. **Tie back to engineering challenge.** **Say:** *On your data collection sheet, circle the papers you think will be best for designing Max's basket.* Once students have made their selection, have them discuss with their partners what paper they selected and why. **Say:** *Tomorrow we will do some tests to see what will happen if the paper gets wet.*

## TEACHER NOTES


**VOCABULARY**

- **Property** Attributes, characteristics, or parts of something that can be defined and measured

**ASSESSMENT**

**Pre-Activity Assessment**
Solicit reasons for why they are in the "Learn" portion of the Engineering Design Process and how learning about paper will help them.

Listen to students' ideas of what is made out of paper in the classroom and the relationship of paper to wood.

**Activity Embedded Assessment**
Listen to student pairs as they discuss paper properties in pairs and as a whole class.

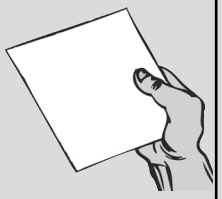
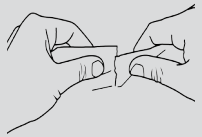
**Post-Activity Assessment**
Review students' **Investigating Paper Properties** data collection sheets to check for understanding and completion.

Lesson 1B

Name_____

# Investigating Paper Properties

**Directions:** Circle the answer that best describes each type of paper.

| types of paper | How does the paper feel?  | | Can you see through the paper?  | | Is the paper easy to rip?  | |
|---|---|---|---|---|---|---|
| 1. copy paper | smooth | bumpy | yes | no | yes | no |
| 2. construction paper | smooth | bumpy | yes | no | yes | no |
| 3. waxed paper | smooth | bumpy | yes | no | yes | no |
| 4. tissue paper | smooth | bumpy | yes | no | yes | no |
| 5. paper towel | smooth | bumpy | yes | no | yes | no |

Lesson 2A

**FOCUS/KEY CONCEPTS**

Students will be able to:

- **Literacy:** point to, say, and blend three letters in sound boxes that represent the phonemes of a word.
- **Literacy and Science:** discuss the text being read and answer questions about water.

**STANDARDS**

- CCSS - ELA: RF.K.2.B, RF.K.2.C, RF.K.2.D

**MATERIALS**

- **Per student: Sound Boxes** sheet
- **Per class:** *I Get Wet* by Vikki Cobb, large copy or projection of the **Sound Boxes** handout

**TEACHER PREPARATION**

- Have a copy of the book, *I Get Wet*
- Prepare a copy of the **Sound Boxes** sheet for each student

**VOCABULARY**

- **Pour** Fast movement of something (usually a liquid) from one place to another
- **Shape** Form (or outline) of an object
- **Flow** Move along or out in a steady and consistent stream
- **Stick** To attach to something

# I Get Wet - Part 1

## SUMMARY OF THE LESSON

In this literacy lesson, students learn about the properties of water through the first part of the book, *I Get Wet* by Vikki Cobb - a nonfiction science text. Students build skills to help with the development of phonemic awareness by identifying the letters representing sounds from the story. As students are writing the letters of three phoneme words in sounds boxes, they are also learning about water and some of its properties. In the previous lesson, students learned about the observable properties of the papers they would be using, and this lesson not only builds background knowledge about water, but also sets the context for lesson 2B. Since this is a longer nonfiction book, this lesson only goes up through the first part of the book, where the question, what happens when you place a drop of water on wax paper, is posed in the book and then explored in the related STEM+C lesson (2B). Reading strategy: blending three phoneme words.

## INTRODUCTION

1. **Tie to engineering challenge.** Ask students questions to get them thinking about how their learning connects to the engineering design challenge. **Ask:** *When thinking about collecting rocks, why do we care about water?* The rocks might be wet or dry. *If we are making baskets to help us carry the rocks* (that might be dry or wet), *why is it important to learn about water and what water does to paper?*

2. **Think about properties of paper and water.** Help students start thinking about water and what it does when it comes in contact with different items by asking them questions about what they know regarding what happens if paper gets wet. **Ask:** *What happens when you spill a glass of water?* The water goes everywhere. *How do you clean up spilled water?* Use a paper towel. *Why is a paper towel good?* The paper towel soaks up the water. *What happens to the paper towel? What does it feel and look like after you have used it to clean up water?*

3. **Identify where they are in the engineering design process. (Learn)** Remind students that an important part of the engineering design process is learning about the problem and ways to solve the problem. Engineers need to learn about water because the rocks might be wet, and the design must work for both wet and dry rocks.

## ACTIVITY - Blending three phoneme words:

4. **Introduce the book.** *I Get Wet* (Science Play Series) by Vikki Cobb. This is a science informational book that is designed to provide readers with developmentally appropriate information about water.

5. **Introduce the skill. Say:** *Who is ready to learn about water and some of the things that makes water so cool? We just talked about some of the ideas you have about water, now we are going to listen to the story to learn more. After we read this book we are going to work on our blending of sounds to make words. This is where I am going to give you the sounds to a word, and I want you to first tell me the word, and then we are going to trace the letter that make those words as we make their sounds and blend them together in our sound boxes.*

6. **Start reading.** **Read the first part of the story stopping right after you read about placing the waxed paper under water and pose the question about whether or not the waxed is wet.** (**STOP BEFORE** the answer is given). When reading remember to use some of the things that help students' development:

# I Get Wet - Part 1

- Teach new vocabulary at the point of contact
- Target the reading skill - blending phonemes to generate words from the story
- Encourage higher-level thinking and comprehension monitoring by pausing for "teacher think alouds" and asking questions about or discussing the text

7. **Re-read and practice.** **Say:** *Now we are going to practice blending our sounds to make words. I am going to say several words from the story. See if you can tell me what each one is. Then we'll trace each word on our papers.*

   *Go back to the beginning of the story and re-read the pages where you will have students blending sounds. While you read the sentence in which they appear, give the sounds for the following three-phoneme words and have the students blend them into the correct word:*
   - Page 1: know the fastest way to cool off on a hot summer day? hot, /h/ /o/ /t/, hot
   - Page 2: You get wet? get, /g/ /e/ /t/, get, wet, /w/ /e/ /t/, wet
   - Page 5: You can see it. You can feel it. can, /c/ /a/ /n/, can

8. **Individual practice.** Pass out the **Sound Boxes** sheets. **Say:** *Now that we have sounded out these words from the story, we are going to practice again by tracing each word that we just said.*

   Here is an example of how you could use the sound boxes with your students to help them trace and sound out the letters and then blend them into words. **Say:** *Put your finger on the number one. In the first box trace the letter h, what sound does that letter make again? It is the letter for the sound you first hear in hot. In the next box, trace the letter o, which is the letter sound you hear next in hot? In the last box, trace the letter t, which is the letter for the sound you hear at the end of hot - /h/ /o/ /t/, hot. Put your finger by the number one. Run your finger under each sound as we say the word together - /h/ /o/ /t/, hot.* Repeat with get, wet, and can.

## CLOSURE

9. **Post-reading.** Have students review the science ideas they learned. **Ask**: *In the book it talked about how you can use water to help you cool down on a hot day, what else can you do with water?* We can get clean, get wet, drink it, and pour it into different shaped glasses. *What happens if you pour water on the table or a flat surface?* The water spreads out. *What about if you pour it into a glass?* It is the shape of the glass. *What shape is water?* It is the shape of the container. *What happens when water comes out of the faucet?*

10. **Tie back to the engineering challenge.** Help students start connecting what they learned in this lesson with the next STEM lesson as well as back to the engineering design challenge. **Ask:** *What do you think happens when water touches paper?* The water soaks into the paper. **Say:** *If we are thinking about making our basket out of paper and we know that our rocks can sometimes be wet, we should probably do a little experiment to find out what happens when paper gets wet.*

## TEACHER NOTES

Lesson 2A

**ASSESSMENT**

**Pre-Activity Assessment**
Help students start thinking about water and what it does when it comes in contact with different items by asking them questions about what they know regarding what happens if paper gets wet. **Ask:** *What happens when you spill a glass of water? How do you clean up spilled water? Why is a paper towel good? What happens to the paper towel? What does it feel and look like after you have used it to clean up water?*

**Activity Embedded Assessment**
Listen and watch for students abilities as they sound out and blend the three phoneme words.

Once you have finished sounding out the words together, pass out the **Sound Boxes** sheets to have students practice their phonemic blending again by tracing each of the words that they blended out loud.

**Post-Activity Assessment**
Listen for answers to questions asked about water from text.

Lesson 2A

Name_____

# Sound Boxes

**Directions:** Trace each letter as you blend the sounds to create a word.

| | | | |
|---|---|---|---|
| 1. | h | o | t |
| 2. | g | e | t |
| 3. | w | e | t |
| 4. | c | a | n |

Lesson 2B

# Investigating Paper & Water

**FOCUS/KEY CONCEPTS**

Students will be able to:

- **Science:** investigate that properties are characteristics that something has.
- **Engineering:** Ask questions, make observations, and gather information to define a problem about a situation people want to change through developing a new tool.

**STANDARDS**

- NGSS: K-2-ETS1-1, P4

**MATERIALS**

- **Per student:** white crayon, **Water Drop Test Observation Sheet**
- **Per pair:** (1) 4"x4" square of copy paper, (1) 4"x4" square of wax paper, (1) pipette or eye dropper, (1) plastic cup of colored water, optional: bag of paper samples from Lesson 1B
- **Per class:** *I Get Wet* by Vicki Cobb, food coloring, timer, Paper Properties Charts, pitcher of water or water source

**TEACHER PREPARATION**

- Prepare a copy of the **Water Drop Test Observation Sheet** for each student
- Prepare "pair" materials listed in the above

**VOCABULARY**

- **Investigate** Carry out a study to find out the facts

## SUMMARY OF THE LESSON

In this STEM+C lesson, students investigate what happens when water drops are placed on different types of papers by conducting a water drop test on regular, wax, and wax-coated paper. This lesson helps familiarize students with wax paper, which is a less familiar paper, and how wax and copy paper are affected by water. While the wax paper is not as strong as copy paper when dry, it holds up better when wet. This is an important step for students as it starts to introduce some of the trade-offs that come with the final design challenge of needing to carry both wet and dry rocks.

## INTRODUCTION

1. **Recall information.** Have students recall what they learned about properties of water and paper from reading *I Get Wet*.

2. **Tie to engineering challenge.** Ask students to recall Max and Lola's problem. **Say:** *Remember, we need to design a basket out of paper and the basket needs to carry dry and wet rocks. Today we will investigate different types of paper and observe what happens to paper when it gets wet.*

3. **Identify where they are in the engineering design process. (Learn)** Remind students that an important part of the engineering design process is learning about the problem and ways to solve it. Engineers need to learn about the materials they will use so they can make a design that meets the problem criteria.

4. **Activate prior knowledge. Ask:** *Have you ever accidentally gotten a piece of paper wet? What happens to the paper?*

## ACTIVITY - Exploring water drops and paper

5. **Investigate waxed and copy paper. Say:** *We will start our investigation by observing what happens to waxed paper and copy paper when we place a large drop of water on it and try to let the drop slide off of the paper back into the cup. Do you think we can get the water to slide off without getting the papers wet?* Allow students to share their predictions about each type of paper.

   Demonstrate how to use a pipette (or eye dropper). Let students practice.

   Have students work in pairs to place a large drop of water on to a piece of waxed paper (have one student hold the paper taut and the other student place the drop of water onto the paper). Students should then angle the paper to try to allow the drop of water to slide back into a cup. They should then inspect the paper to see if it got wet. Students should repeat these same steps for the copy paper.

   Have students share their observations. Record any new findings, observations, or insights on the Paper Properties Charts.

   Optional: Give students all five types of paper to touch. Have them arrange the squares into two piles: paper that will let water slide off

without getting wet and paper that will get wet. Have students explain how they sorted them. Have students do the water drop slide test on each type of paper.

6. **Transition into next investigation.** **Ask:** *Why did the waxed paper repel the water?* Accept all reasonable responses. **Ask:** *What do you think will happen if we put our own wax coating on the other papers?* Explain that because crayons are made of the same material as the special coating on the waxed paper, we will use them to see whether putting a wax coating on paper changes what happens with the paper after contact with the water.

7. **Investigate impact of wax coating.** Give each student a **Water Drop Test Observation Sheet**. Instruct students to use a white crayon to completely color in the box labeled Crayon Colored Copy Paper. NOTE: It is important that the wax completely covers the paper. If tables are not completely smooth, have students put another sheet of paper under the handout so they can coat the paper. Hint: Have students lift and angle their paper to see places they may have missed when coloring.

   Each student should use an eye dropper or pipette to place a large drop of colored water into the plain and colored in boxes. Students should record in the boxes what they observe when they place the drops of water on their paper.
   NOTE: You may need to demonstrate what goes in each of the boxes on the **Water Drop Test Observation Sheet**. Students will need guidance about how to look at the drop of water from the top view and the side view.

   After two minutes have passed, encourage students to see if they can move the water around on the paper. What happens if the water gets off the crayon part and onto the regular paper?

   Ask students to feel the waxed paper sample and the crayon-coated paper. Have them describe how they are similar and how they are different.

   Add any new observations or findings to the Paper Properties Charts.

## CLOSURE

8. **Make real world connections.** **Ask:** *Have you seen wax paper around your house or other places? What problems might waxed paper be designed to solve?*

9. **Tie back to the engineering challenge.** **Ask:** *Which papers do you think will be best for designing Max's basket? Why?* Have students think about their answer and then share it with a partner.

Lesson 2B

**ASSESSMENT**

**Pre-Activity Assessment**
Solicit reasons for why they are in the "Learn" portion of the Engineering Design Process, and how learning about paper strength will help them.

**Activity Embedded Assessment**
Listen to students' additions to the Paper Properties Charts. Listen to students' descriptions of the differences between waxed and copy paper.

**Post-Activity Assessment**
Listen to students' ideas about which papers they would choose to design baskets and their reasons for choosing them. Review students' responses to the **Water Drop Test Observation Sheet.**

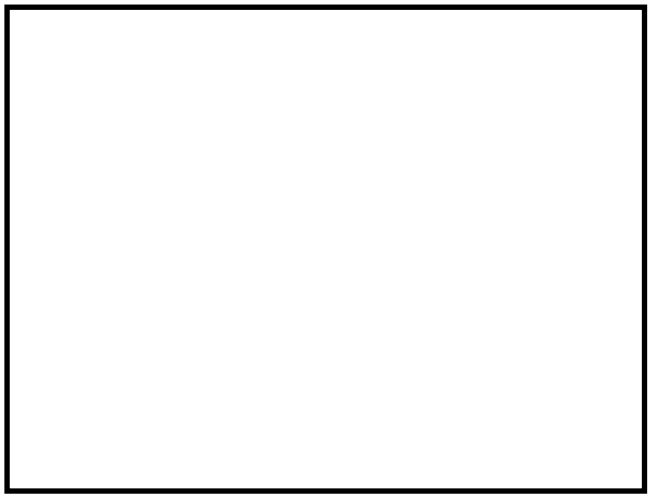
**TEACHER NOTES**

Lesson 2B

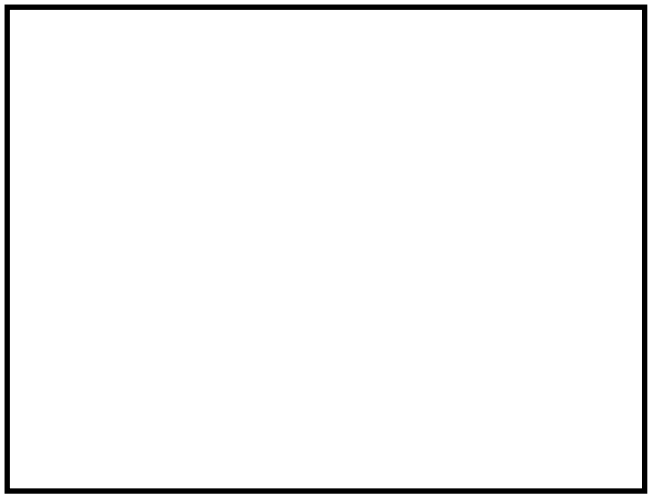
Name_____

# Water Drop Test Observation Sheet

plain copy paper



crayon-colored copy paper



| plain copy paper | crayon-colored copy paper |
|---|---|
| side view | side view |
| _____ | _____ |
| top view | top view |
|  |  |


**FOCUS/KEY CONCEPTS**

Students will be able to:

- **Literacy:** discuss the text they are reading and answer questions about what they learned about water.
- **Literacy:** summarize the text as a class using interactive writing.

**STANDARDS**

- CCSS - ELA: RL.K.1, RL.K.2, W.K.2, SL.K.2, L.K.1.A, L.K.1.F

**MATERIALS**

- **Per student: Summary Worksheet**
- **Per class:** *I Get Wet* by Vikki Cobb

**TEACHER PREPARATION**

- Have a copy of the book, *I Get Wet*
- Prepare a copy of the **Summary Worksheet** for each student (version 1 or version 2, depending on the writing level of students)

**VOCABULARY**

- **Summary** A short statement of the main points of something

# I Get Wet - Part 2

## SUMMARY OF THE LESSON

In this literacy lesson, students continue to build their reading skills by interactively creating a summary sentence about the text, *I Get Wet* by Vikki Cobb. This second part of the book picks up where they left off in Lesson 2A, by providing an answer to the question about water and wax paper that was investigated in Lesson 2B. Reading strategy: summarizing informational text.

## INTRODUCTION

1. **Connect to the first half of the book.** Ask students questions to help them recall what they learned about water from *I Get Wet*. **Ask:** *What happened to the copy paper, what did it feel and look like after you dripped water on it? What happened to the waxed paper, what did it feel and look like after you dripped water on it?*

2. **Tie to engineering challenge. Ask:** *When thinking about collecting rocks, why do we care about water?* The rocks might be wet or dry. *If we are making baskets to help us carry rocks (that might be dry or wet), why is it important to learn about water and what water does to paper?*

3. **Identify where they are in the engineering design process. (Learn)** Remind students that an important part of the engineering design process is learning about the problem and ways to solve the problem. Engineers need to learn about water because the rocks might be wet, and the design must work for both wet and dry rocks.

## ACTIVITY - Summarizing informational text

4. **Re-introduce the book.** *I Get Wet* by Vikki Cobb.

5. **Introduce the skill. Say:** *After reading a book, to tell your friends what you learned about the book or why they should read it, you need to summarize what the book is about.*
   NOTE: It is important for the development of students' literacy skills to be able to summarize information they gain from reading. In this lesson, you are focusing on interactively creating a summary sentence of informational text (the book *I Get Wet*).

   **Ask:** *Who is ready to learn more about water and some of the things that make water so cool? As we continue reading this story about water, think about how you would tell someone else what happens in the book.*

6. **Start reading.** Read the second part of the story beginning with the page about wax paper (to remind students of the context). Remember to use some of the things that help their development:
   - Teach new vocabulary at the point of contact
   - Target the reading skill - summarizing the informational text
   - Encourage higher-level thinking and comprehension monitoring by pausing for "teacher think alouds" and asking questions about or discussing the text

# I Get Wet - Part 2

7. **Post-reading.** Ask students to think about what they learned from the book. **Ask:** *What does water do?, Are all papers the same?, and What did the boy from the book do with water and paper?*

8. **Create a summary sentence.** Have students come up with a summary sentence and share it with a partner. When all students have come up with sentences, have them share their summary sentences with the class.

   The class will interactively create a summary sentence for the text. Using students' ideas, lead the discussion to a simple summary sentence, such as, *You get wet because water sticks to you*. Have students help sound out the words and spell them as you write the sentence on the board or a large piece of chart paper. Have students write the sentence on the **Summary Worksheet.**

## CLOSURE

8. **Post-reading.** Have students review the STEM ideas they learned. **Ask:** *Why does the water wet paper?* Water sticks to the paper. *Does water stick to you? How do you know?* Yes. Your skin soaks up the water.

9. **Tie back to the engineering challenge.** Sometimes Max and his friends carry home wet rocks. **Ask:** *Do you think that will make a difference for how you choose paper and design your basket?*

## TEACHER NOTES

Lesson 3A

**ASSESSMENT**

**Pre-Activity Assessment**
Ask the students to summarize what they remember from the first part of the book.

**Activity Embedded Assessment**
Listen to students as they tell their narrative sentences to each other.

**Post-Activity Assessment**
Students should have written the same sentence as on the board on their **Summary Worksheets**.

Lesson 3A

Name_____

## Summary Worksheet: Version 1

**Directions:** Write the sentence the class made together.

Lesson 3A

Name_____

# Summary Worksheet: Version 2

**Directions:** Write your summary sentence.

**Directions:** Write the sentence the class made together.

Lesson 3B

# Investigating Paper Strength

## SUMMARY OF THE LESSON

In this STEM+C lesson, students build upon their knowledge and understanding of the different properties of paper to start to form predictions about how well these papers will carry rocks. After making predictions about the different types of paper and how they will perform when dry and wet, students use rocks to test the strength of these different papers when wet and when dry. Students then sort the papers based on their strength when wet and when dry and connect to the design challenge by sharing ideas about which papers might be better (or worse) for their paper basket designs.

## INTRODUCTION

1. **Tie to engineering challenge.** Remind students of the design challenge and that they are trying to find papers that are strong enough to carry rocks when dry and when wet. Show them samples of all five kinds of paper that will be tested. **Ask:** *How do you think we could find out if these papers are strong enough to hold rocks?* Accept all reasonable responses.

2. **Identify where they are in the engineering design process. (Learn)** Remind students that an important part of the engineering design process is learning about the problem and ways to solve the problem. Engineers need to learn about the materials they will use so they can make a design that meets the project criteria.

## ACTIVITY - Investigating Paper Strength

3. **Introduce the investigation.** **Say:** *Today, we will test the strength of all of the papers when they're dry and when they're wet by placing rocks on the paper and observing what happens.* Show students a bag of the rocks. **Ask:** *How do you think we should decide if the paper stays strong?* Accept all reasonable responses. Pass out the **Investigating Paper Strength: Dry & Wet Paper Test** data collection sheet (two-sided).

4. **Investigate paper strength when dry.** Have students find the side that says Dry Paper Test. NOTE: This is done as a class. You can have pairs test papers if you want a more hands-on experience for the students.
   - Ask students to circle their prediction about whether or not they think the copy paper will hold 20 rocks.
   - Demonstrate the DRY test for students. Ask two volunteers to hold a piece of copy paper taut over the plastic container. Demonstrate how to place the 20 rocks one at a time gently in the center of the paper. Slowly count out loud to 20 before setting down the paper. After the test, inspect the paper for tears or other signs that it was not strong enough to hold the rocks.
   - Ask students to circle their predictions about whether or not each of the remaining papers (construction, wax, tissue, and paper towel) will hold 20 rocks on the data collection sheet for dry rocks.
   - Continue with the DRY paper test for each of the different papers, asking for different volunteers for each paper.
   - After completing the test, have them categorize how strong each type of paper is – strong, medium, weak.
   - Add students' observations to the Paper Properties Charts.

## FOCUS/KEY CONCEPTS

Students will be able to:

- **Science:** describe that the strength of the paper is dependent on the properties of the paper.
- **Engineering:** ask questions, make observations, and gather information to define a problem about a situation people want to change through developing a new tool.

## STANDARDS

- CCSS - ELA: SL.K.1
- CCSS - Math: K.CC.A.3, K.CC.B.4, K.CC.B.5, K.CC.C.6
- NGSS: K-2-ETS1-1, K-2-ETS1-3, P3, P4

## MATERIALS

- **Per student: Investigating Paper Strength** data collection sheets
- **Per class:** 8.5"x11" sheets of the following: copy paper, construction paper, tissue paper, waxed paper, paper towel, Paper Properties Charts, (1) tub, (20) medium-sized rocks (river rocks), (1) cup of water, (1) eyedropper or pipette, (1) test station, extra paper towels or cloth towels to dry off rocks and testing station

## TEACHER PREPARATION

- Prepare a two-sided copy of the **Investigating Paper Strength: Dry Paper Test & Wet Paper Test** data collection sheet (1/student)
- Prepare a set of papers (2 each), eyedropper/pipette, and rocks for demonstration

# Investigating Paper Strength

5. **Investigate paper strength when wet.** Have students turn their papers over to the side that says Wet Paper Test.
   - Have students circle their prediction about whether or not they think the copy paper will hold 20 rocks when wet.
   - Demonstrate the WET test in same manner as the DRY test, but put four eyedropper full amounts/pipettes of water in the center of the paper and count to 10 before putting rocks on the paper. Rocks should sit directly on top of the wet location. Again, once all 20 rocks have been placed, count to 20 before setting down the paper and removing the rocks. After the test, inspect the paper for tears or other signs that it was not strong enough to hold the rocks.
   - Ask students to circle their predictions about whether or not each paper will hold 20 rocks when wet on the handout.
   - Continue with the WET paper test for each of the different papers, asking for different volunteers for each paper. NOTE: It is helpful to have paper towels to dry off rocks in between testing each paper.
   - After completing the test, have them categorize how strong each type of paper is when wet – strong, medium, weak.
   - Add students' observations to the Paper Properties Charts.

## CLOSURE

6. **Report and record observations.** As a class, discuss what students noticed, ask them to share how the experiment results were similar and different from their predictions, and add observations to the Paper Properties Charts.

7. **Tie back to the engineering challenge.** **Ask:** *Based on today's tests, which papers do you think will work well for Max's basket?* Have students circle their answer on one of the handouts. Have students share their answers with a partner.

## TEACHER NOTES

Lesson 3B

**VOCABULARY**

- **Strength** How strong something is
- **Strong** Ability to withstand great force or pressure

**ASSESSMENT**

**Pre-Activity Assessment**
Listen to students' responses for ways to test the paper. Solicit reasons for why they are in the "Learn" portion of the Engineering Design Process and how learning about paper strength will help them.

**Activity Embedded Assessment**
Walk around to be sure students are testing their papers by holding the paper taut and gently placing the rocks. Also be sure they are switching roles in their teams. Students should have both their predictions and results recorded on their **Investigating Paper Strength: Dry & Wet Paper Test** data collection sheets.

**Post-Activity Assessment**
Listen as students share their ideas for which paper should be used for Max's basket and why. Responses should also be circled on the **Investigating Paper Strength: Dry & Wet Paper Test** data collection sheets.

Lesson 3B

Name_____

# Investigating Paper Strength: Dry Paper Test

| Type of paper | Do you think it will hold 20 rocks? (circle one) | # of rocks paper held | Describe how the paper looks after testing. (circle one) | How strong was the paper? (circle one) |
|---|---|---|---|---|
| 1. copy paper | yes no | | There was no change. It is not flat. It broke. | strong medium weak |
| 2. construction paper | yes no | | There was no change. It is not flat. It broke. | strong medium weak |
| 3. wax paper | yes no | | There was no change. It is not flat. It broke. | strong medium weak |
| 4. tissue paper | yes no | | There was no change. It is not flat. It broke. | strong medium weak |
| 5. paper towel | yes no | | There was no change. It is not flat. It broke. | strong medium weak |

Lesson 3B

Name_____

# Investigating Paper Strength: Wet Paper Test

| Type of paper | Do you think it will hold 20 rocks? (circle one) | # of rocks paper held | Describe how the paper looks after testing. (circle one) | How strong was the paper? (circle one) |
|---|---|---|---|---|
| 1. copy paper | yes no | | There was no change. It is not flat. It broke. | strong medium weak |
| 2. construction paper | yes no | | There was no change. It is not flat. It broke. | strong medium weak |
| 3. wax paper | yes no | | There was no change. It is not flat. It broke. | strong medium weak |
| 4. tissue paper | yes no | | There was no change. It is not flat. It broke. | strong medium weak |
| 5. paper towel | yes no | | There was no change. It is not flat. It broke. | strong medium weak |

Lesson 4A

# Pattern Fish

## SUMMARY OF THE LESSON

In this literacy lesson, students are introduced to patterns from a book called *Pattern Fish* by Trudy Harris. The students explore rhyme through the poetry in the book. Students will also connect the idea of patterns to the weaving in baskets, as they are presented with different types of weaving patterns that can be used in their final basket designs. This lesson helps students to work on the mathematics concept of pattern recognition by asking students to generate the next item in a pattern through spoken words, colors, and letters. Students also begin to work on abstraction of patterns by assigning letters to repeating patterns. Reading strategy: exploring rhyme.

## INTRODUCTION

1. **Tie to engineering challenge.** Help students recall the engineering challenge and use it to help motivate the lesson. **Say:** *Remember back to our story about Max and Lola.* **Ask:** *What do Max and Lola need you to do?* Make a basket plan to carry rocks. **Ask:** *What are some of the requirements for the basket you are going to make?* It has to carry wet and dry rocks, be pretty, be made out of materials from home, etc. **Say:** *In order to make our baskets pretty, we are going to do some weaving later.* **Ask:** *Have you ever seen something that is weaved?*

2. **Provide examples of basket weaving.** Use images of woven baskets to help students understand weaving.

3. **Identify where they are in the engineering design process. (Learn)** Remind students that an important part of the engineering design process is learning about the problem and ways to solve the problem. Engineers need to learn about the process they can use to solve the problem. **Say:** *Think back to our Engineering Design Process. If we are going to weave our baskets, we need to understand the patterns of weaving. We are going to read a book about patterns called Pattern Fish.*

4. **Introduce problem decomposition.** *(Breaking down tasks into smaller, manageable parts).* **Say:** *Another thing that engineers do as they "learn" about a problem is that sometimes they have to break their big problems into smaller parts since it might be too hard or confusing to work on the whole thing at one time. For this unit, there are two different parts that we are going to need to learn about. The first we have already done which is seeing how the different papers worked when wet and dry.* (Possible time for review). *The second part is learning about how these papers will fit together to make a basket. Weaving is one way that can be used to put two different things, like paper, together.*

   **Say:** *To help us learn about weaving and the different types of weaving, we can look at the patterns that can be made from different types of weaving and that will help us think about all of the different ways we can design our baskets. We are going to read a book about patterns called Pattern Fish.* **Say:** *Then we will combine what we learn about patterns and weaving from today with what we learned about paper properties from yesterday to create our own basket designs.*

5. **Introduce/review poetry as literature.** Tell the students that this book is a type of poetry. Remind the students what makes a book poetry. Also, ask them if they know any books that are poetry (Dr. Seuss' books are good examples, help them tie back to other books you have read together.)

## FOCUS/KEY CONCEPTS

Students will be able to:

- **Literacy:** discuss what makes some literature poetry.
  - generate a rhyming and non-rhyming word for a given keyword.
  - generate pairs of rhyming words.
  - recognize rhyming words in the story.
- **Mathematics:** generate the next item in a pattern through spoken words, colors, letters. Begin work on abstraction of patterns by assigning letters to repeating patterns.
- **Computational Thinking:** *Problem Decomposition* - break down tasks into smaller, manageable parts, *Pattern Recognition* - describe how different patterns repeat and alternate.

## STANDARDS

- CCSS - ELA: RL.K.5, RL.K.7, RL.K.10, RF.K.2.A, RF.K.2.E, SL.K.6
- CSTA: 1A-A-4-4, 1A-A-3-5

## MATERIALS

- **Per student: Pattern Fish - Patterns** worksheet, crayons (red, yellow, and green)
- **Per class:** *Pattern Fish* by Trudy Harris, images of woven baskets
- **Optional: Pattern Fish - Rhyme Assessment** (1 per student)

## TEACHER PREPARATION

- Make copies of ***Pattern Fish - Patterns*** worksheet and optionally the **Pattern Fish - Rhyme Assessment**
- Locate crayons and basket images

# Pattern Fish

## ACTIVITY - Explore rhyme

6. **Introduce the skill.** Discuss what rhyming words are before you read. For example, you might **say:** *King and sing rhyme. They sound the same at the end, /ing/, /k/-/ing/, /s/-/ing/.*
   - Ask the students if they can think of other pairs of words that rhyme.
   - Ask the students if they can think of other words that rhyme with king and sing as well as words that rhyme with the word pairs students suggested. Accept nonsense words.
   - Finally, ask the students to come up with words that don't rhyme with king and sing.

7. **Start reading.** Remember to use some of the things that help students' development:
   - This book naturally allows students to tell you the next word in the pattern. Allow students to provide you with the next word as you read.
   - Teach new vocabulary at the point of contact.
   - Stop on a few pages and have the students identify the words on the page that rhyme.
   - Pick extra words on a page and have the students see if they can find a word that rhymes.
   - Encourage higher-level thinking and comprehension monitoring by pausing for "teacher think alouds" and asking questions.

## ACTIVITY - Identifying patterns

8. **Reread *Pattern Fish*.** Have students explore patterns as they go through the book.

9. **Pattern abstraction.** Hand out the **Pattern Fish - Patterns** worksheet to each student. Have students complete problems 1-3 on the worksheet.

   Next, demonstrate to students that "yellow-black-yellow-black-yellow-black" is an ABAB pattern. You can go through the last two pages of *Pattern Fish* with students to help them. Then ask them to complete problem 4 on the worksheet. **Ask:** *Can you use letters to describe the patterns in problems 1 and 2?*

## CLOSURE

10. **Tie back to engineering challenge.** Remind students about the design challenge and that weaving baskets will be involved.

11. **Use images to determine over-under pattern.**
    - Show students **Basket image 1** (printed out or projected). Help students discover that this is an ABAB pattern, which translates to over-under-over-under, through questioning or having each pair or table discuss and report out
    - Show students **Basket image 2** (printed out or projected). Help students discover that this is an AABBAABB pattern, which translates to over-over-under-under-over-over-under-under, through questioning or having each pair or table discuss and report out.
    - Let students know that this is what we will be working on in the next lesson for our baskets.

## TEACHER NOTES

Lesson 4A

**VOCABULARY**

- **Pattern** A repeated design
- **Engineer** A person who designs products or processes to solve problems or meet a need
- **Poem** Collection of words that express an emotion or idea; sometimes with specific rhythm

**ASSESSMENT**

**Pre-Activity Assessment**
Student discussion regarding ideas about the patterns in the basket images.

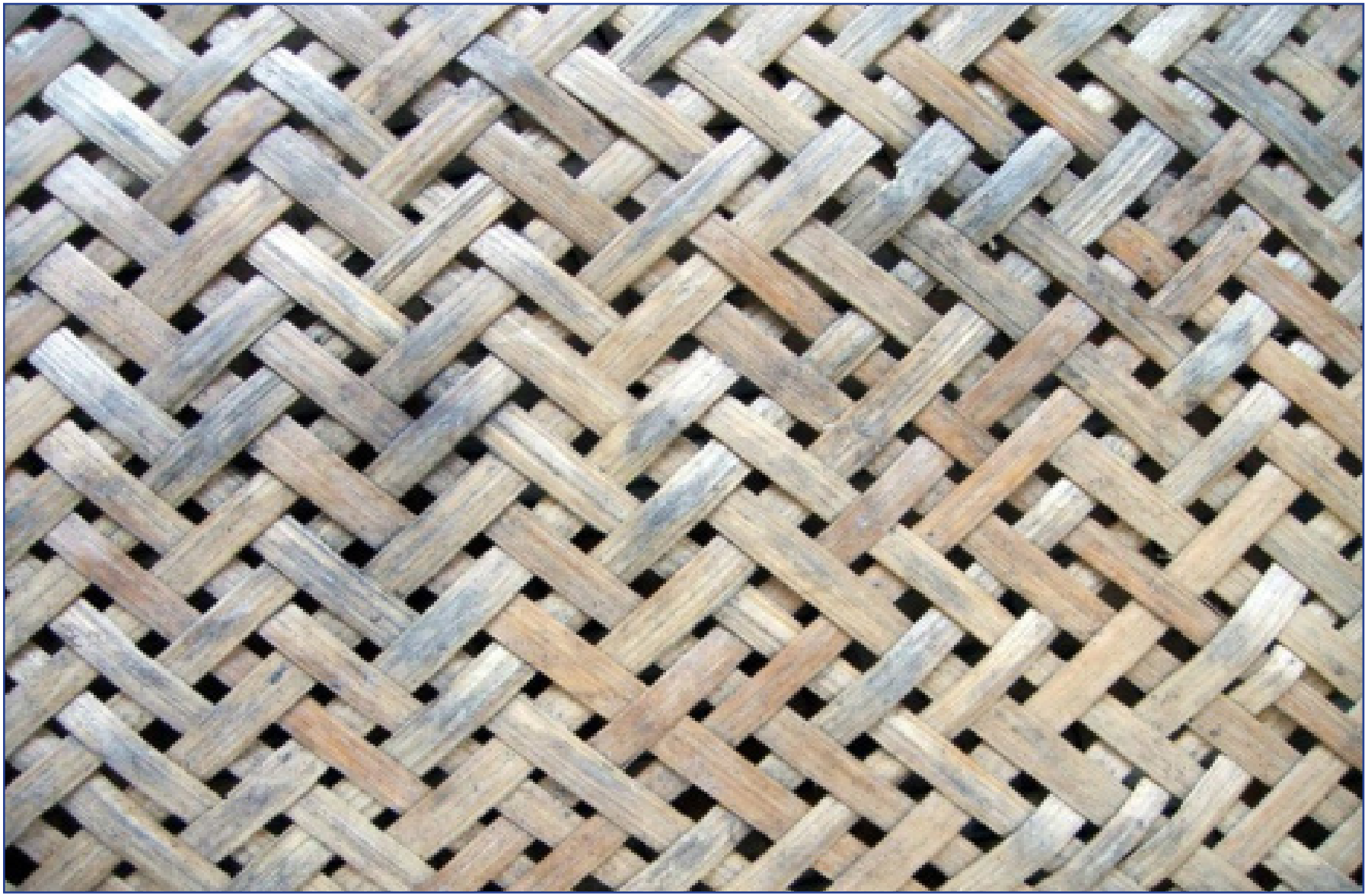
**Activity Embedded Assessment**
Have students fill out the **Pattern Fish - Patterns** worksheet with you as you read the book the second time.

**Post-Activity Assessment**
Optional: Use the **Pattern Fish - Rhyme Assessment** for a summative assessment.

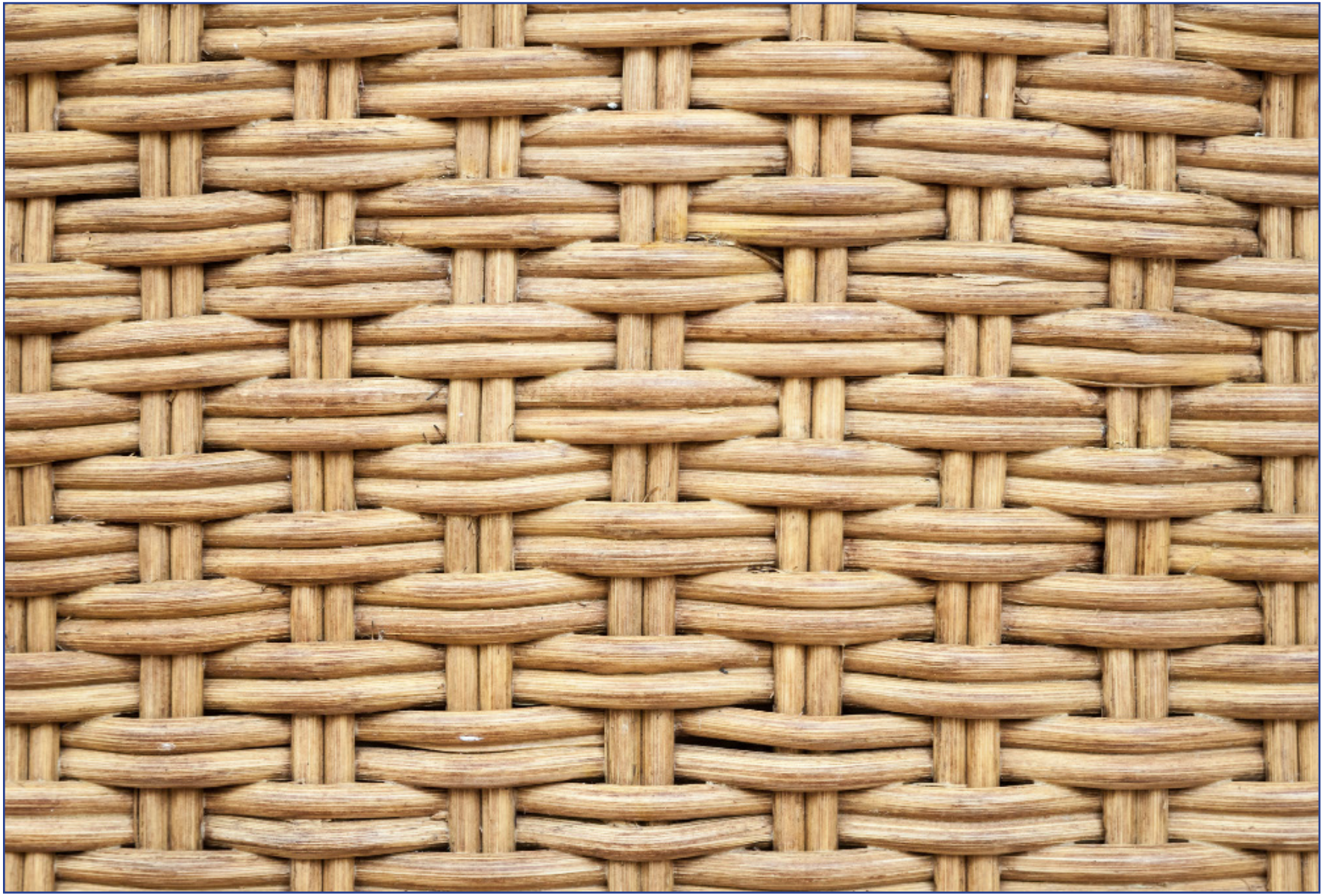
**EXTEND THE LESSON**

More work with patterns: Have students create their own patterns using colored beads and pipe cleaners. Bend the end of the pipe cleaner, so that the beads won't fall off and then let students create and identify their own 2-3 color patterns.

# Basket Image 1



# Basket Image 2



Lesson 4A

# Pattern Fish - Rhyme Assessment

**Directions:** Say, "Tell me a word that rhymes with [use each word in the list below]." Record the student's responses on the lines provided. Nonsense words are okay.

Name of student _____

| Test Items | Student Response |
|---|---|
| 1. pop | _____ |
| 2. dot | _____ |
| 3. black | _____ |
| 4. kite | _____ |
| 5. red | _____ |
| 6. spot | _____ |
| 7. hook | _____ |
| 8. ball | _____ |
| **Total Rhymes Correct** | _____ |

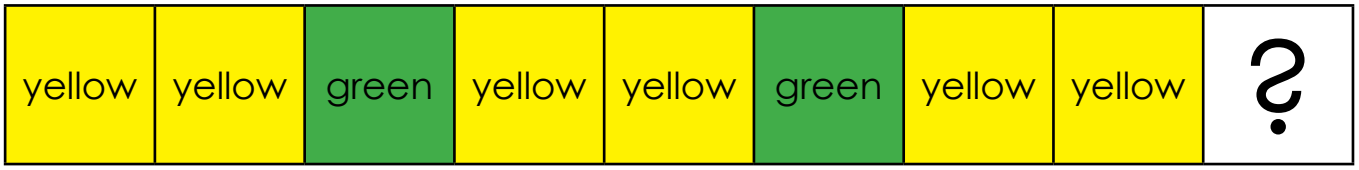
Lesson 4A

Name_____

# Pattern Fish - Patterns

**Directions:** Color the next box in the pattern.

1.

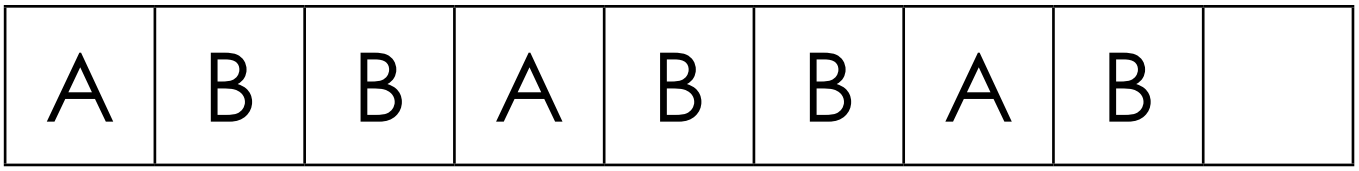



2.


---

**Directions:** Write the next letter in the pattern.

3.




---

**4. Use letters to describe the patterns in problems 1 and 2.**

# Pattern Fish - Patterns

**Directions:** Color the next box in the pattern.

1.

| yellow | yellow | green | yellow | yellow | green | yellow | yellow | ? |
|---|---|---|---|---|---|---|---|---|
| A | A | B | A | A | B | A | A | B |

2.

| red | green | yellow | red | green | yellow | red | green | ? |
|---|---|---|---|---|---|---|---|---|
| A | B | C | A | B | C | A | B | C |

---

**Directions:** Write the next letter in the pattern.

3.

| A | B | B | A | B | B | A | B | **B** |
|---|---|---|---|---|---|---|---|---|

---

**4. Use letters to describe the patterns in problems 1 and 2.**

Students may write the answers under the patterns in 1 and 2 as shown above if helpful.

Lesson 4B

# Patterns in Weaving

## SUMMARY OF THE LESSON

In this STEM+C lesson, students continue to build on the work they did with patterns in the literacy lesson, 4A, as they look at four different patterns that can be used in their final basket designs. The focus of this lesson is on weaving and alternating patterns as they work to understand why alternating patterns are important to the strength of their baskets. After exploring these four different patterns, as a class they complete a simulation of testing dry rocks with the different patterns before moving into a discussion of why certain patterns are stronger or weaker.

## INTRODUCTION

1. **Tie to engineering challenge.** Remind students of the design challenge and that they are trying to design a basket that is not only strong and can carry dry and wet rocks but that also looks nice. Today they will be learning about patterns for weaving.

2. **Identify where they are in the engineering design process. (Learn)** Remind students that an important part of the design process is learning more about the different concepts that will be using as they move in the solution generation phase of the design process. To better understand the problem engineers must learn about the science and other factors that impact how the problem can be solved. As they learn, engineers must keep the problem and its criteria in mind, so that they can take all of the information they learned to make a good plan.

## ACTIVITY - Investigating weaving patterns

3. **Introduce the activity.** Show them an example of a paper weaving made from 2 different colors of construction paper (using ABAB pattern). **Ask:** *What patterns can you see in this weaving?*
   - Show students the template from Lola (base and strips) and a sample basket made using the template.
   - Tell students that they will be making a weaving as part of their basket design. Tell them that TWO patterns will play an important role in these weaving patterns. **Ask:** *Has anyone made a weaving like this before?*
   - Using student volunteers, demonstrate the weaving process for students. **Ask:** *What patterns do you SEE?* (Alternating colors). *What patterns do you HEAR?* ("over-under-over-under" and "under-over-under-over").
   - Move into discussion about weaving and how weaving is combining two things together to form patterns in different directions (horizontal, vertical, diagonal). Tell students that in this lesson they will be exploring different weaving patterns.

4. **Identifying weaving (and alternating) patterns.** Use the basket images and **Pattern Weaving Examples** to explore different weaving patterns. Hand out a copy of the **Weaving Patterns** worksheet to each student.

## FOCUS/KEY CONCEPTS

Students will be able to:

- **Science:** use a model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- **Engineering:** investigate how the woven pattern changes the strength.
- **Mathematics:** recognize and identify patterns (focus on identification and abstraction to letters).
- **Computational Thinking - Pattern Recognition:** explore how different patterns repeat and alternate in basket designs.

## STANDARDS

- CCSS - ELA: SL.K.2, L.K.1.A
- NGSS: K-2-ETS1-1, P3
- CSTA: 1A-A-4-4

## MATERIALS

- **Per student: Weaving Patterns** worksheet
- **Per class:** (1) set of 20 rocks, (1) large tub, (1 each type) construction paper version of the **Pattern Weaving Examples**

## TEACHER PREPARATION

- Make a construction paper version of each of the **Pattern Weaving Examples ABAB, AABB, AABAAB, ABAB not alternating**
- Set up the testing station

## VOCABULARY

- **Model** A representation of something

# Patterns in Weaving

Using the **Pattern Weaving Example ABAB** (or your handmade version), ask students what letters would show the "over-under-over-under" pattern? The "under-over-under-over" pattern? Have students label the ABAB on row #1 and BABA on row #2 of the their own **Weaving Patterns** worksheet. Lead a discussion about how the pattern is alternating as you move down the rows. Have students fill out the rest of number 1 on the worksheet.

Work through the second pattern example using the same process (use **Pattern Weaving Example AABB** or handmade version) - start your discussion with "over-over-under-under", then help students go to the general AABB.

Depending on student comfort level, you can continue to model the first line with problems 3 and 4 or allow students to work on their own.

Share student ideas about Pattern #4 (ABAB not alternating, "over-under-over-under", "over-under-over-under"). **Ask:** *What do you think will happen in a basket that does not alternate between the rows? How well will it hold rocks?* Take answers and lead students to think about gaps that might be created.

Allow students to create their own weaving pattern. Using either colors and/or letters, allow students to complete the boxes for #5 on the worksheet.

## CLOSURE

5. **Tie back to the engineering challenge.** **Ask:** *Which of the weaving patterns we have seen today is your favorite? Why?* Take answers. **Ask:** *Do you think some will work better to hold rocks than others? Which ones? Why?* Take answers.

   As a class, complete a simulation of testing dry rocks with the different patterns (while keeping the paper flat like in 3B) and move into the discussion of why certain patterns are stronger or weaker (i.e., the AABB has more of a chance for the rocks to slip through the holes and the ABAB not alternating does not hold together well). NOTE: Use the testing tub for the rocks to fall into.

   **Say:** *Think about the different weaving patterns from today.* **Ask:** *Which ones do you think will meet the criteria Max and Lola have set up for us? Why do you think so?* Take answers.

## TEACHER NOTES


**Pre-Activity Assessment**
Listen to students' responses to the patterns that they see during the introduction to weaving. Assess their current understanding and look for connections they make to the *Pattern Fish* reading from Lesson 4A.

**Activity-Embedded Assessment**
Assess student understanding as they fill out the **Weaving Patterns** worksheet.

**Post-Activity Assessment**
During the closure, consider student ideas of which weaving will work best for the criteria set up to design the baskets.

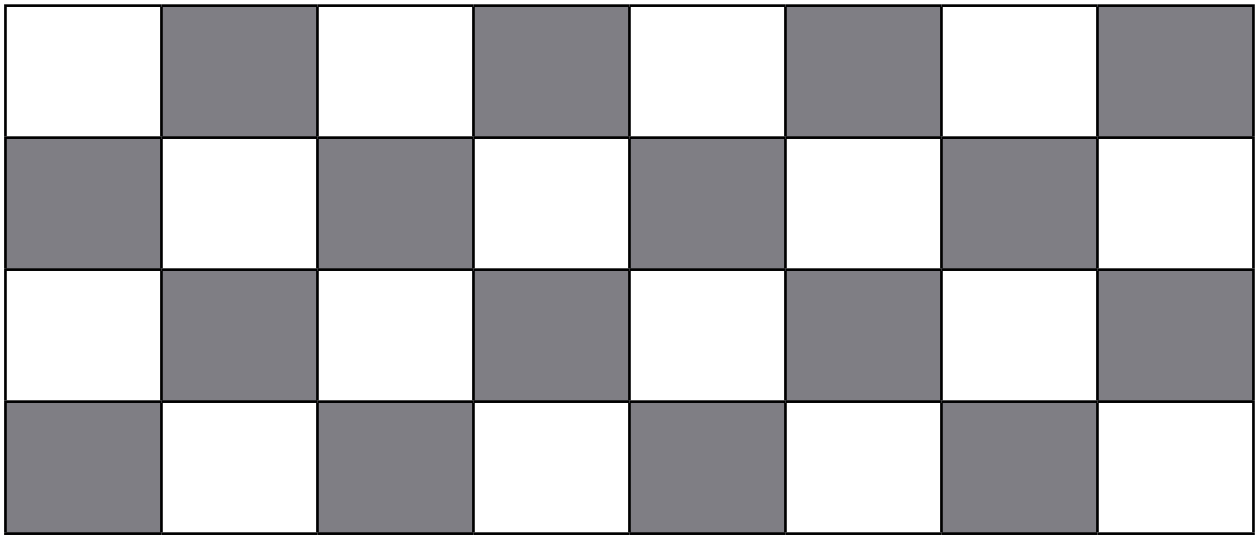
Lesson 4B

Name_____

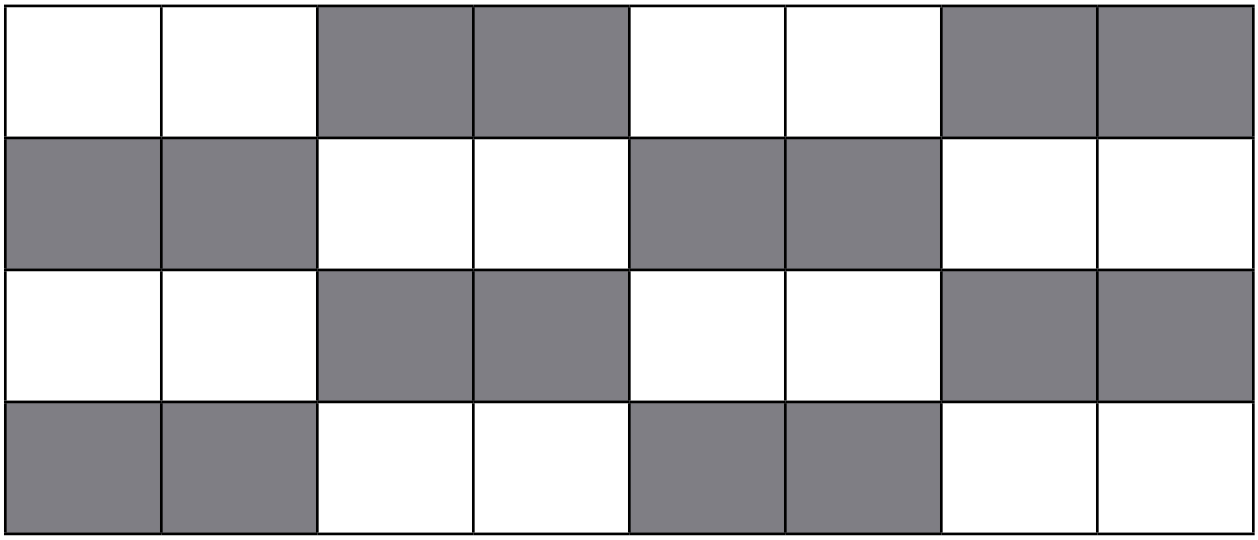
# Weaving Patterns

Use letters to show the pattern that you see in the boxes below.

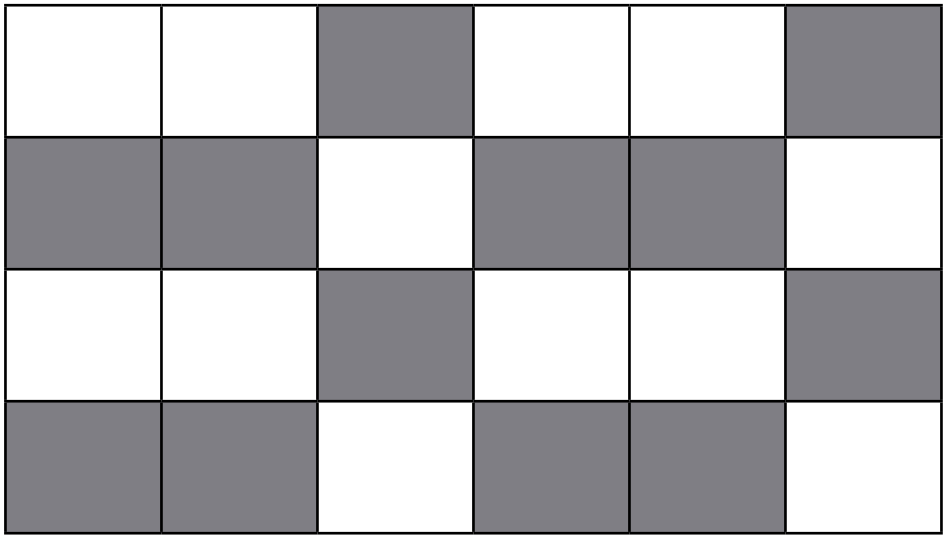
1.



2.



3.

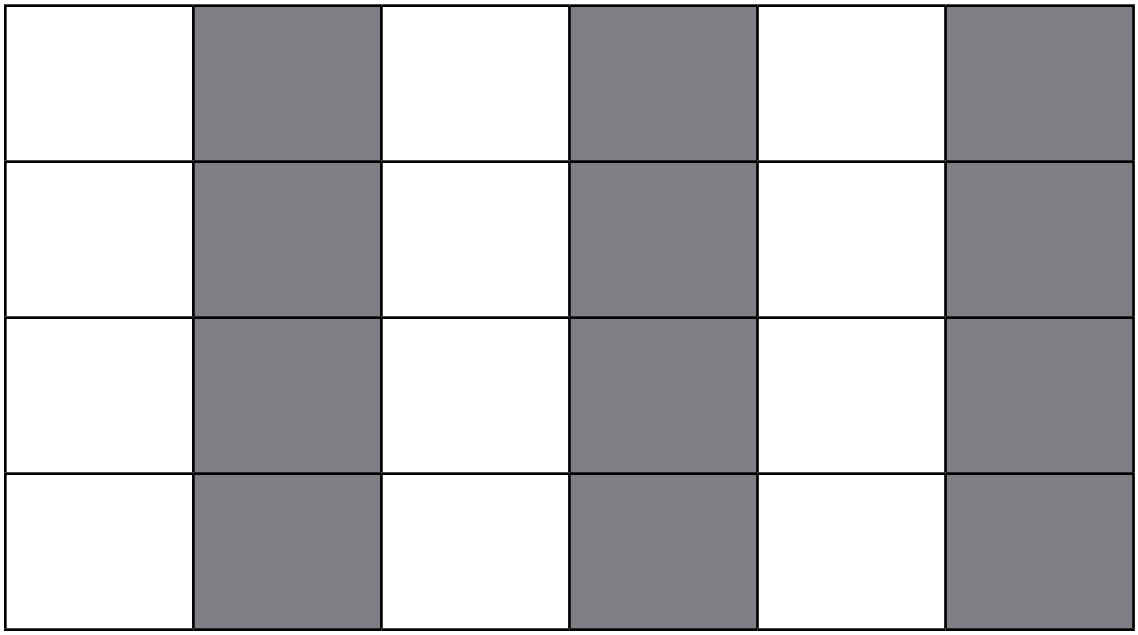


Lesson 4B

Name_____

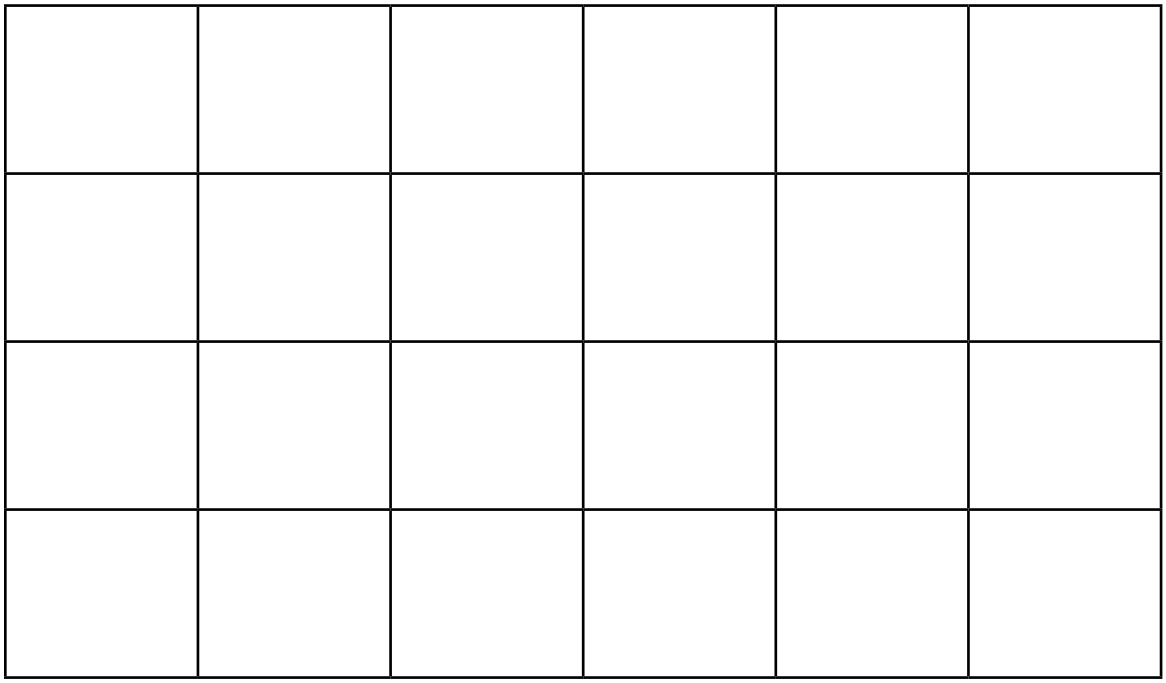
# Weaving Patterns

4.



Create your own weaving pattern.

5.



Lesson 4B

Name KEY

# Weaving Patterns (Educator Resource)

Use letters to show the pattern that you see in the boxes below.

1.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | B | A | B | A | B | A | B |
| B | A | B | A | B | A | B | A |
| A | B | A | B | A | B | A | B |
| B | A | B | A | B | A | B | A |

2.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | A | B | B | A | A | B | B |
| B | B | A | A | B | B | A | A |
| A | A | B | B | A | A | B | B |
| B | B | A | A | B | B | A | A |

3.

| | | | | | |
|---|---|---|---|---|---|
| A | A | B | A | A | B |
| B | B | A | B | B | A |
| A | A | B | A | A | B |
| B | B | A | B | B | A |

Lesson 4B

Name KEY

# Weaving Patterns (Educator Resource)

4.

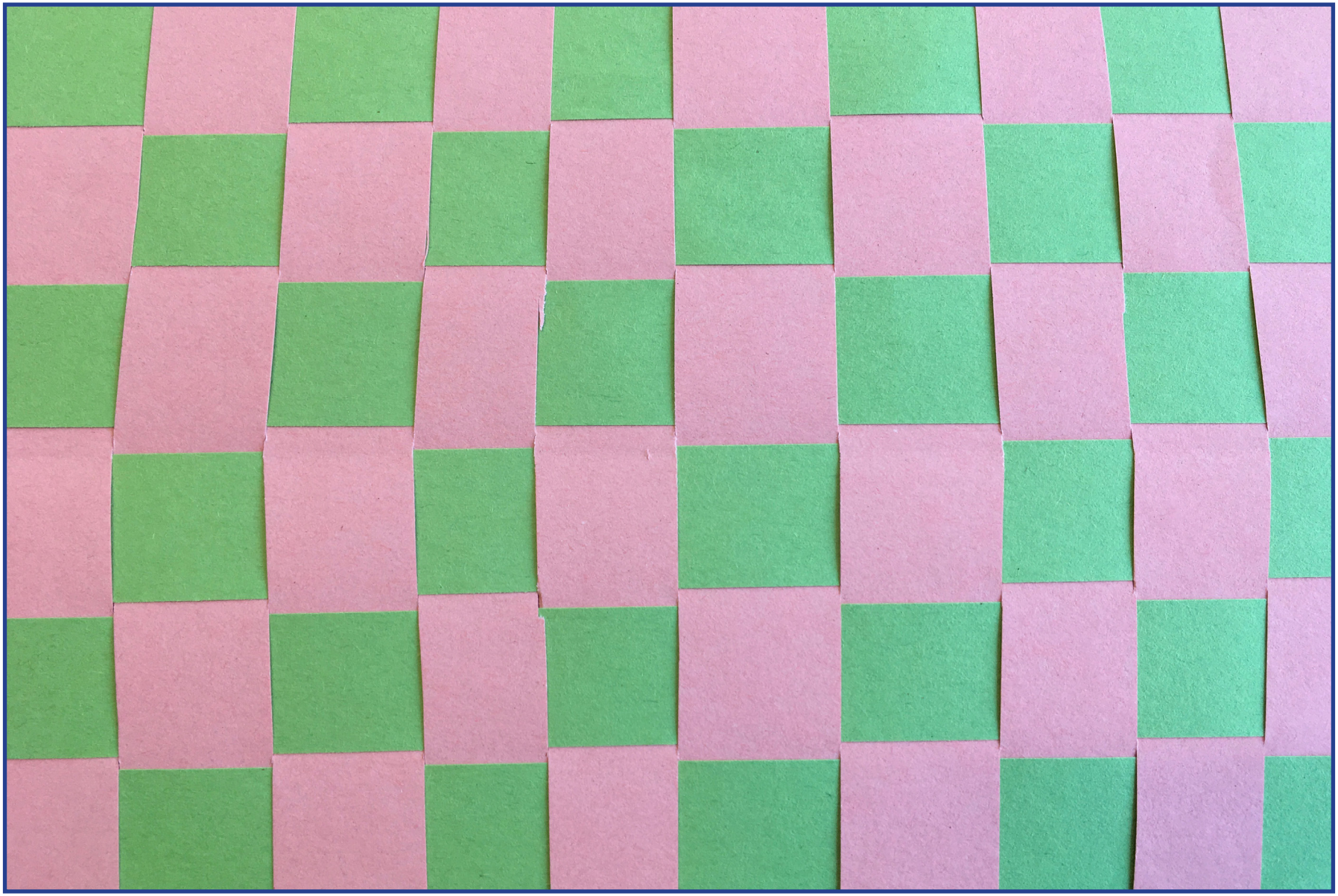
| | | | | | |
|---|---|---|---|---|---|
| A | B | A | B | A | B |
| A | B | A | B | A | B |
| A | B | A | B | A | B |
| A | B | A | B | A | B |

Create your own weaving pattern.

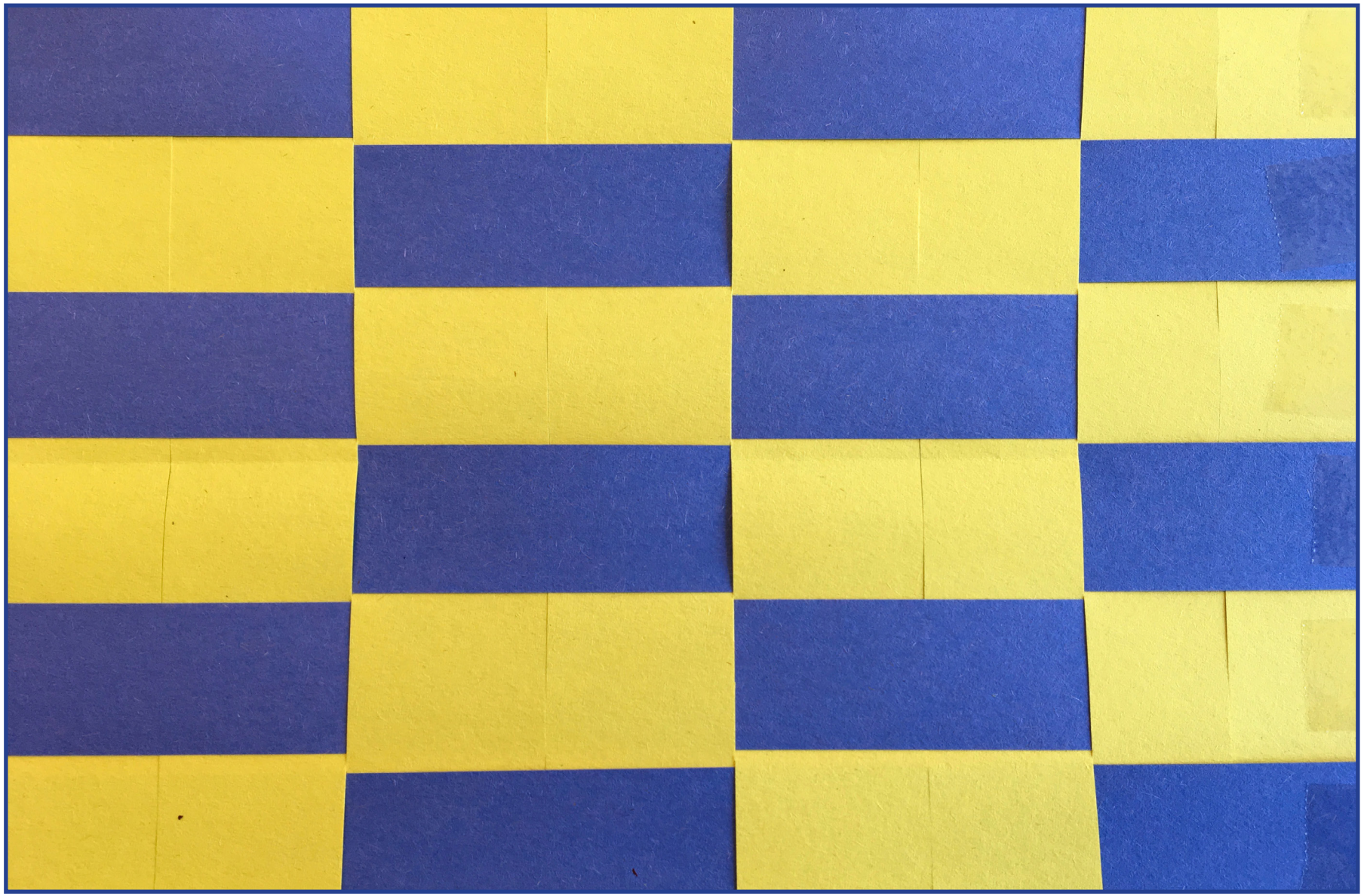
5.

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

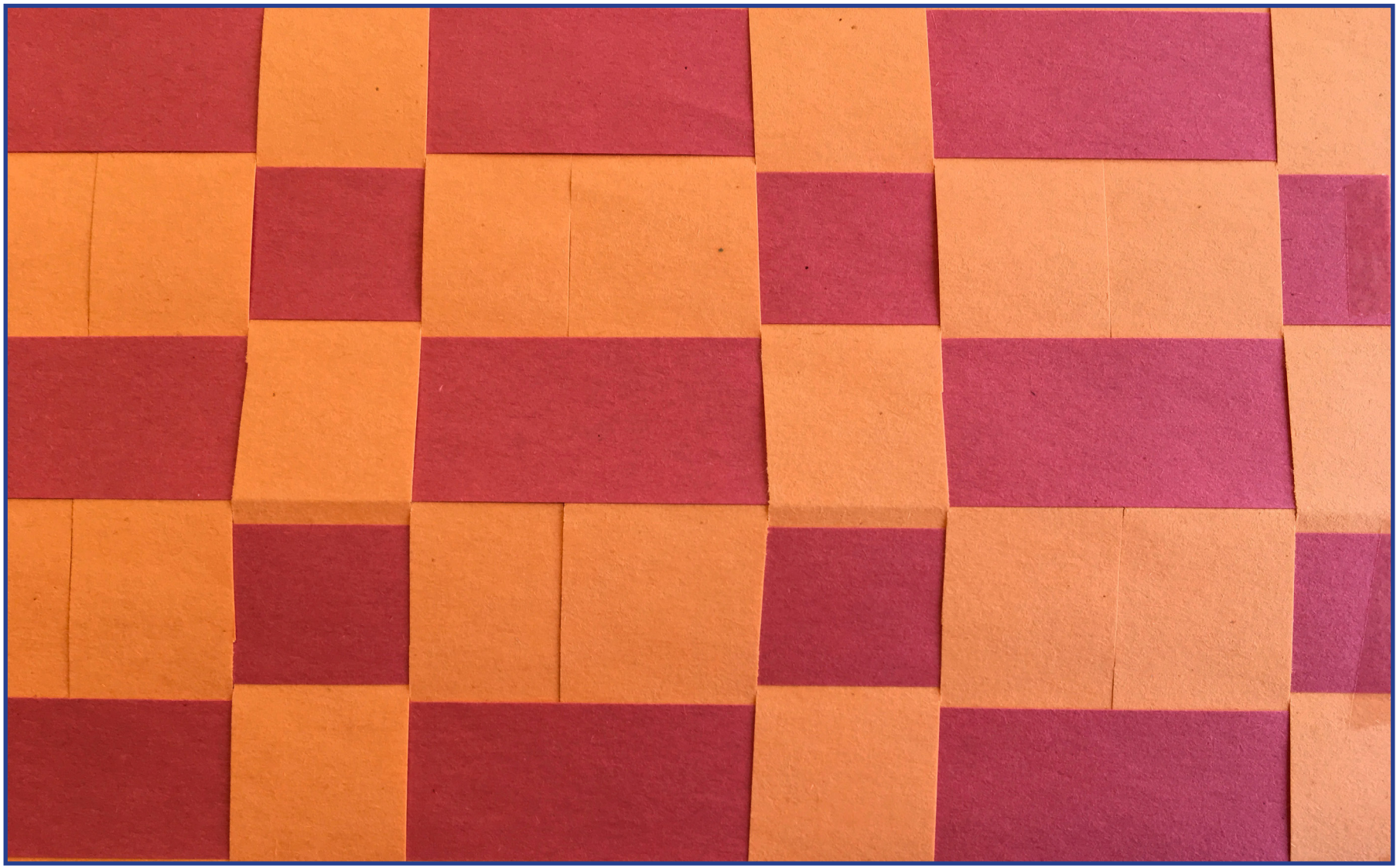
# Pattern Weaving Example ABAB



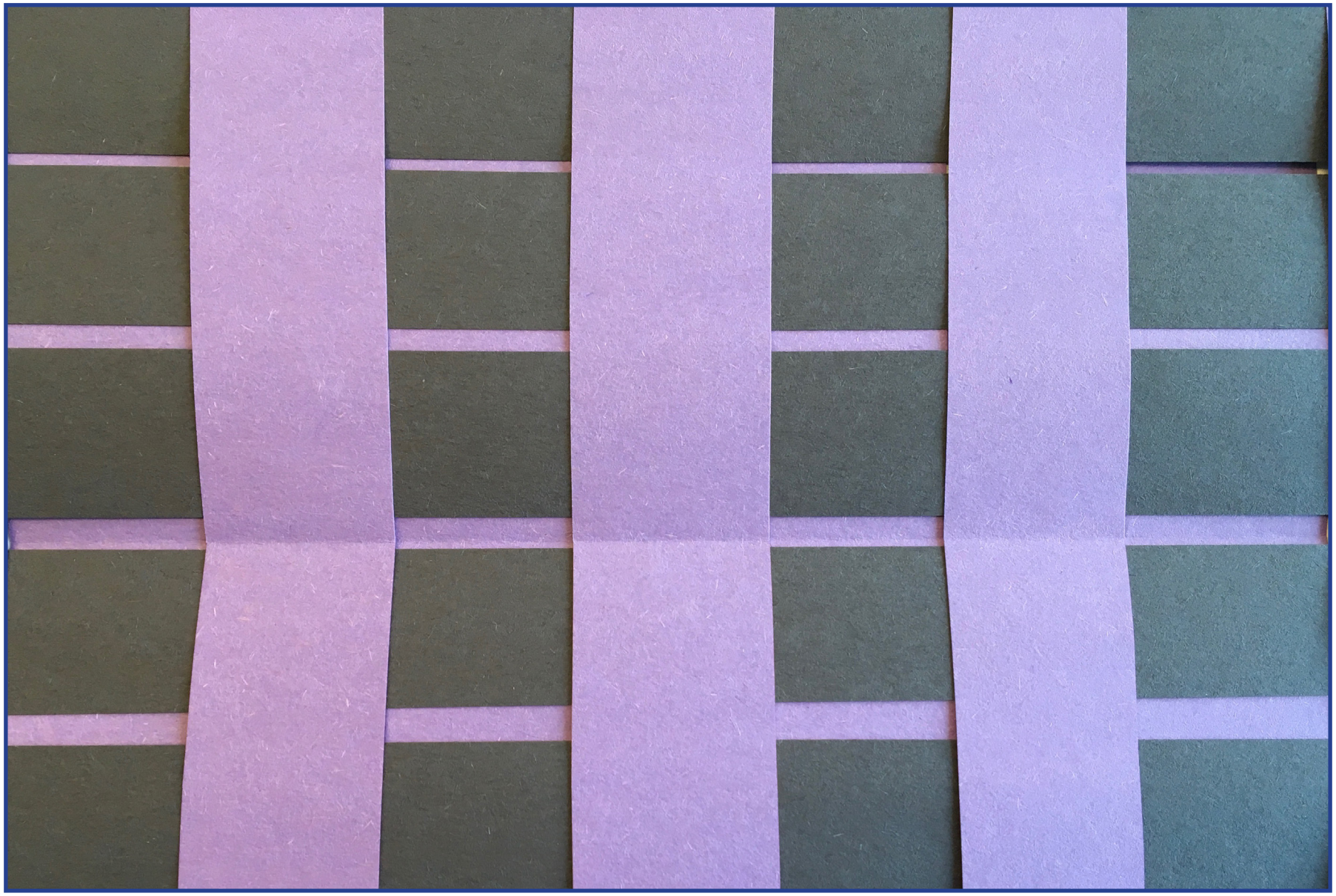
# Pattern Weaving Example AABB



# Pattern Weaving Example AABAAB



# Pattern Weaving Example ABAB (not alternating)



Lesson 5A

# The Most Magnificent Thing

**FOCUS/KEY CONCEPTS**

Students will be able to:

- **Literacy:** engage in high level talk about a text, make connections between the story and their own lives.
- **Engineering:** recognize that failure and perseverance are needed if the basket fails.

**STANDARDS**

- CCSS - ELA: RL.k.3, RL.K.9, W.K.2, SL.K.1, SL.K.2

**MATERIALS**

- **Per student: Making Connections** graphic organizer
- **Per class:** *The Most Magnificent Thing* by Ashley Spires, chart paper

**TEACHER PREPARATION**

- Make copies of **Making Connections** graphic organizer
- Make large copy of the **Making Connections** graphic organizer

**VOCABULARY**

- **Engineer** A person who designs products or processes to solve problems or meet a need

## SUMMARY OF THE LESSON

In this literacy lesson, students practice high level talk about text as they learn about a girl who overcomes failure to create the perfect thing for her and her bulldog sidekick by reading *The Most Magnificent Thing* by Ashley Spires. After reading the story, students will practice making connections between what they are reading and their own lives as they work on increasing their comprehension of texts. The focus on failure and perseverance are important reminders for students as this lesson start to transition from building background knowledge needed for their design into actually planning and working on their basket designs. Additionally, this lesson helps students to understand that sometimes we have good ideas in our head that can be difficult to get out on paper. Reading strategy: making connections.

## INTRODUCTION

1. **Tie to engineering challenge.** Discuss the design challenge with students. **Ask:** *What are we working on for Max and Lola?* Designing a basket that is not only strong and can carry dry and wet rocks, but that also looks nice. Introduce that later today they will continue to work as engineers as they start on the solution generation part of the design process.

2. **Identify where they are in the engineering design process (Learn).** Remind students that an important part of the design process is planning their design before they make it. Engineers need to take all of the information they learned to make a good plan, and then they can move on to try the plan and make a prototype of their design. Engineers need a good plan before they can try the design. **Say**: *We are going to be starting on our basket designs next, and sometimes we have these good ideas in our head, and it can be difficult to get them out on paper, so this story is about a little engineer with that problem - she can't get her idea to be just right. I want you to pay attention to what happens and what she does as she is working towards her design.*

3. **Introduction to literacy lesson.** Help students start thinking about making connections between this story and their own experiences with ideas that didn't work or other types of failure. **Ask:** *Who has ever had a really great idea? What was it and what did you do with that really great idea? Did anyone have a really great idea that they tried out and it didn't work out so well? What did you do then?* Gather a few answers to help students begin making connections to one of the underlying theme of the book - perseverance. **Say:** *Today, we will read a story about a little girl who has this great idea to make the most magnificent thing, and we will see what she does with her great idea. While we are reading, I want you to be thinking about connections between your ideas and experiences and what happens to her.*

## ACTIVITY - Making connections:

4. **Introduce the book.** Introduce students to the book *The Most Magnificent Thing* by Ashley Spires.

# The Most Magnificent Thing

Show students the cover and tell them that it is a fictional story about a girl and her adventures as an engineer with this great idea to create the most magnificent thing. Explain that as you read you want them to pay attention to some of the things that this little girl does as she creates her "magnificent thing," because they are going to continue to think and act like engineers to solve Max and Lola's problem.

5. **Introduce the skill.** **Say:** *After we have finished reading, we will also be working on becoming better readers by making connections to our lives. Good readers take time to think about what they read and relate it to something in their lives or something they know. This helps them to understand what they read.*

6. **Start Reading.** Read the book. Remember to use some of the things that help their development:
   - Teach new vocabulary at the point of contact, some examples could include magnificent, wonderful, or assistant
   - Target the reading skill – making connections to text
   - Encourage higher-level thinking and comprehension monitoring by pausing for "teacher think alouds" and asking questions about or discussing the text

7. **Re-read and practice.** Go back to the page just before she gets mad and **say:** *Good readers make connections when they read. If you were this little girl what would you have done if you had tried all of these different things and nothing was right? Turn to a neighbor and tell them how you would feel if you were this little girl.* Continue with high-level talk about this story and help them to make connections by asking students for ideas about what this little girl did (she got mad) and if there was ever a time when they got mad because something didn't work. Then discuss what she did after she got mad (she started breaking it and crunched her finger), then how she calmed down (went for a walk) and then what happened after she calmed down. After finishing the discussion, have students fill in the **Making Connections** graphic organizer with pictures or words.

## CLOSURE

8. **Tie back to engineering challenge.** Remind students that they are working like engineers to help Max and Lola. **Ask:** *What happened in our story with the little girl who had that great idea?* At first she wasn't able to make what she had in mind, but she tried again and again until she got it right. ***Say:*** *Sometimes things don't work the first time or they might run into problems along the way (*the basket might fail), *but, like the story, you need to keep trying because you never know when you will create the "most magnificent thing."* You also want to tie the idea of failure back into their basket testing - **Ask:** *Why do you think we are testing our baskets until they fail?*


**Pre-Activity Assessment**
Assess that students know what they are designing through questioning.

**Activity Embedded Assessment**
Use the **Making Connections** graphic organizer to assess students literacy development.

**Post-Activity Assessment**
During the closure, listen for students making connections between what the girl in the story did and what they will do when they make their baskets.

**TEACHER NOTES**

Lesson 5A

Name_____

# Making Connections

Use words or draw pictures with words.

| happened in the story | | connection to my life |
|---|---|---|
| | → | |
| | → | |
| | → | |

Lesson 5B

# Designing Baskets

**FOCUS/KEY CONCEPTS**

Students will be able to:

- **Mathematics:** apply what they have learned about alternating patterns and strength to their designs.
- **Science:** use a model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- **Engineering:** develop a simple model based on evidence to represent a proposed tool.
- **Computational Thinking:** Debugging/Pattern Recognition - identify errors in the repetition of simple patterns.

**STANDARDS**

- CCSS-ELA: SL.K.6
- NGSS: K-2-ETS1-2, P2
- CSTA: 1A-A-5-3, 1A-A-6-8

**MATERIALS**

- **Per student: Basket Design Plan** sheet
- **Per pair:** paper basket template, yarn
- **Per class: Pattern Debugging** images, (~90 each kind) paper strips for weaving (construction paper, copy paper, waxed paper, tissue paper, paper towel), (3) roll of cellophane tape

**TEACHER PREPARATION**

- Make at least 1 copy each of the educator resource **Pattern Debugging**
- Prepare **Basket Design Plan** (1 per student)
- Prepare templates for each group by folding copy paper in half (hot dog style) and making 8 slits in the paper
- Prepare yarn loops

## SUMMARY OF THE LESSON

In this STEM+C lesson, students will work on their debugging skills. Before using what they learned about patterns from Lesson 4A & 4B to decide which pattern to use in their own designs, students will identify the errors in different weaving patterns. Students will also use what they learned about the properties of paper (Lessons 1B & 2B) and paper strength (Lesson 3B) to make decisions about which papers to use in their basket design.

## INTRODUCTION

1. **Tie to engineering challenge.** **Ask:** *What are we supposed to be designing for Max and Lola?* Paper baskets. **Ask:** *What are the criteria we have for the baskets we are designing?* They need to carry many wet and dry rocks and look nice. Tell them that today they will be using what they learned about the different types of paper and patterns as they create their basket plan. **Ask:** *What do you think we have learned about in the past few days that will help us design our baskets?* Take answers and try to help them see that the pattern and investigation of paper activities will be useful today.

2. **Identify where they are in the engineering design process. (Plan)** Remind students that an important part of the design process is planning their design before they make it. Engineers need to take all of the information they learned to make a good plan. When there is a final plan, then they can try the plan and make a prototype of their design. Engineers need a good plan before they can try the design. Move the sliders paper clip to "plan."

## ACTIVITY - Designing Baskets and Basket Weaving

3. **Create a basket plan.** Distribute the **Basket Design Plan**. In pairs, have students discuss the two options for their baskets and mark their choices on the design plan. First, they should decide which paper they would like to use for their strips (six strips per group). Second, they will need to decide which pattern they will use to make their basket. Have students share their reasons for their paper choices and basket patterns with you prior to letting them get their paper supplies.

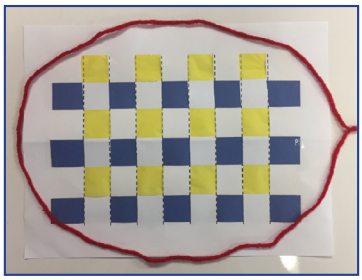
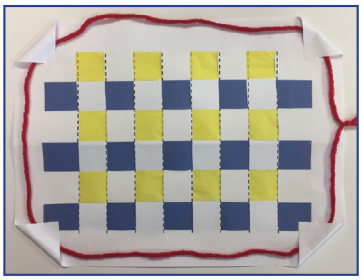
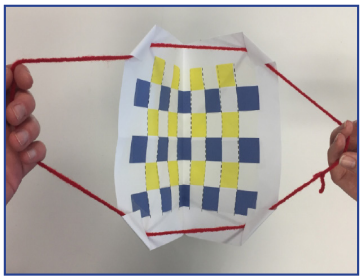
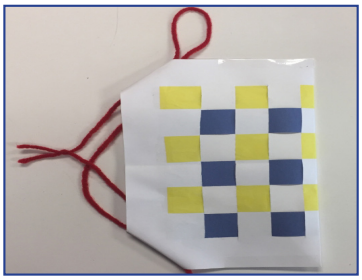
4. **Debugging activity.** Introduce the word "debugging" to students. Debugging means to find an error (or a mistake) and correct it. **Say:** *Before we begin to try our baskets, we are going to think about how to notice mistakes in our basket weaving and correct them. You can think of mistakes as "bugs" and we want to de-"bug" solutions to get rid of the "bugs" - or correct the mistakes.* Use the **Pattern Debugging** educator resource pages to show students improperly woven baskets. **Ask:** *Where is the weaving error in this basket?* Take answers. **Ask:** *What do you think can be done to correct the error?* Take answers. Explain that this activity is an example of debugging. Tie this to the idea of failure and perseverance from the literacy lesson (5A) and what to do if you notice that it is not going the way you planned (missed a weave or did not alternate between rows).
NOTE: An optional way to do this lesson is to use the **Pattern Debugging** educator resources to prepare construction paper versions of these for students to debug by hand (miss a weave or not

# Designing Baskets

alternate rows). This is a good performance assessment.

5. **Identify where they are in the engineering design process. (Try)** Remind students that an important part of the design process is planning their design before they make it. Engineers need to take all of the information they learned to make a good plan. When there is a final plan, they can try the plan and make a prototype of their design. Engineers need a good plan before they can try the design.

6. **Try the plan.** Have pairs work to complete weaving patterns. When the basket is finished, help pairs to attach the string by folding and taping the four corners of their base paper around the looped string. Pull on the string at two opposite shorter ends of the basket template to bring those ends close together (hamburger fold) and make the flat template look more like a basket. Tape the sides.

While waiting for all groups to finish, pairs can decide what they will tell the class about their design.
NOTE: Students can use their design plan to help, but it can be helpful to provide the following sentence starters on the board: "The basket strips we used were…", "We decided to use an _____ pattern for our basket".

## CLOSURE

6. **Tie back to the engineering challenge.** Have pairs show their basket to the class and explain the following (prompt students as necessary):
   - why they chose the papers they did;
   - how their basket meets Max and Lola's needs;
   - how they think their basket will perform on the wet and dry tests;
   - what patterns they chose and why.

## TEACHER NOTES

Lesson 5B

- Prepare 1" strips from 5 paper samples for pairs to chose from
- Write sentence starters on the board

**VOCABULARY**

- **Error** A mistake
- **Debugging** The process of finding an error and correcting it.

**ASSESSMENT**

**Pre-Activity Assessment**
Listen to the answers students give about what they are designing and if they can recognize the math, science, and computational thinking activities that will be useful for them as they design their baskets.

**Activity Embedded Assessment**
Check students' **Basket Design Plan** for evidence of learning. Ask students questions about why they chose the papers for the basket.

Use the debugging activity to identify students' recognition of patterns, the ability to see errors, and ability to explain how to correct it.

**Post-Activity Assessment**
Ensure each pair of students has a completed basket. Listen to answers to the prompts during the closure for ties to the STEM+C content from previous lessons.

**EXTEND THE LESSON**
Have students use the Kodable App to focus on coding and debugging.

Lesson 5B

Name_____

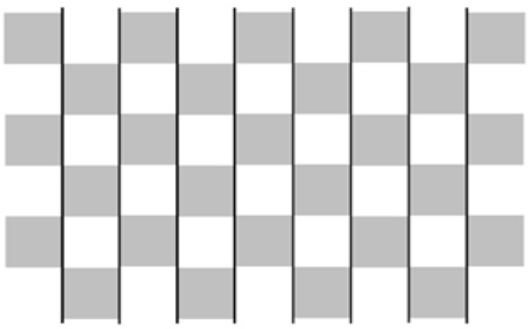
# Basket Design Plan

1. The basket strips I will use are:

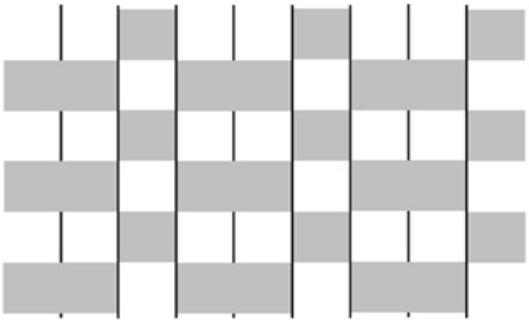
- ☐ 1. copy paper
- ☐ 2. construction paper
- ☐ 3. waxed paper
- ☐ 4. tissue paper
- ☐ 5. paper towel

2. Circle the pattern you will use to make your basket. You may design your own.

A.



B.



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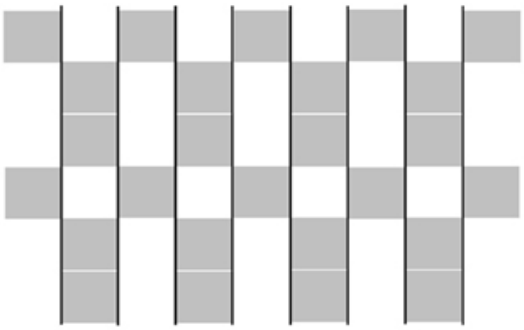

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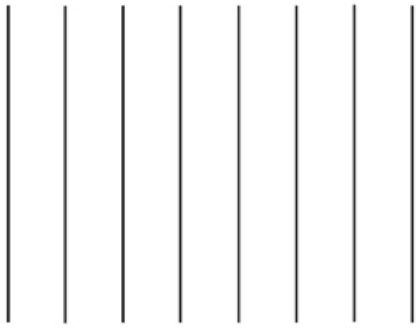
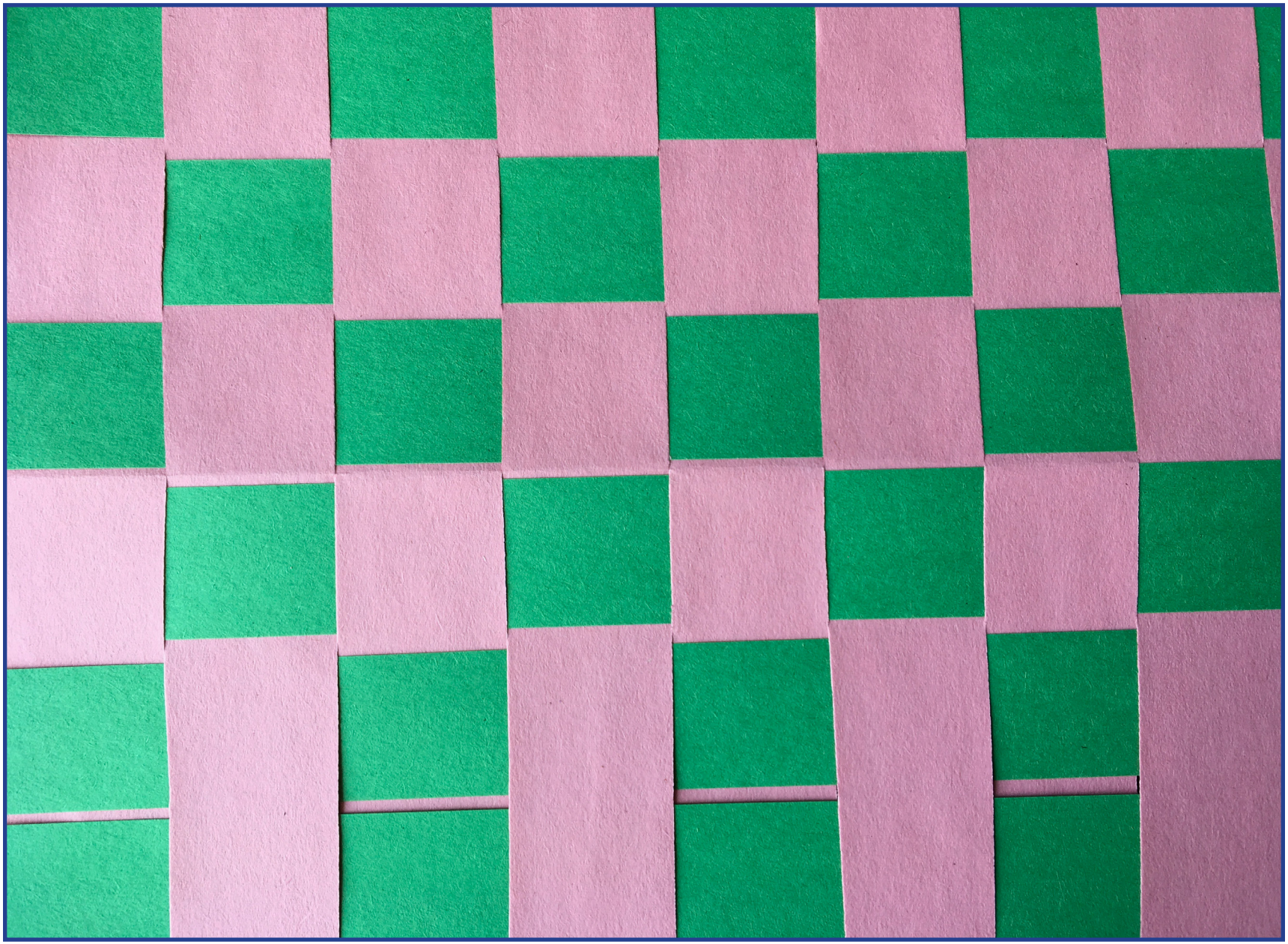
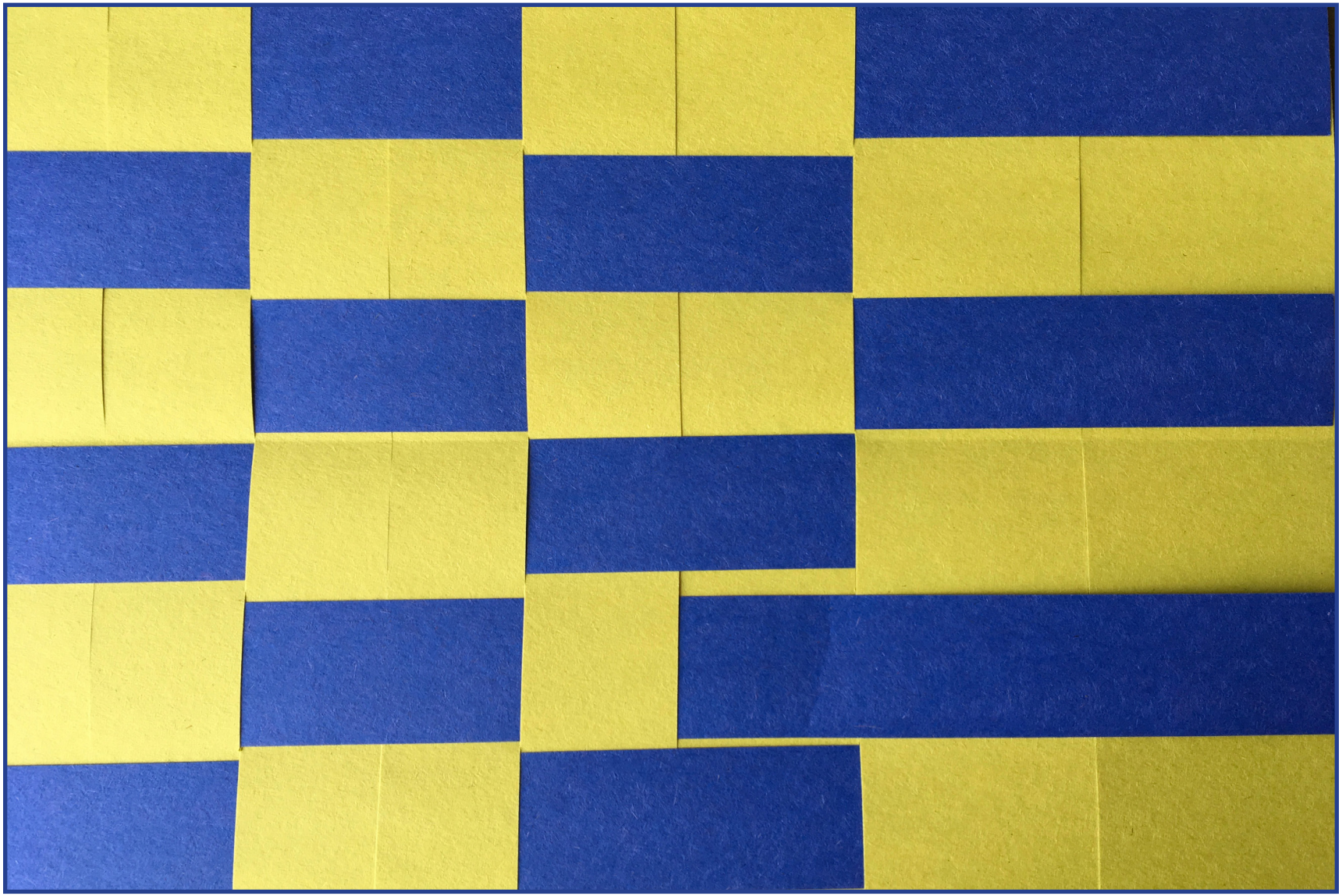


# Pattern Debugging ABAB

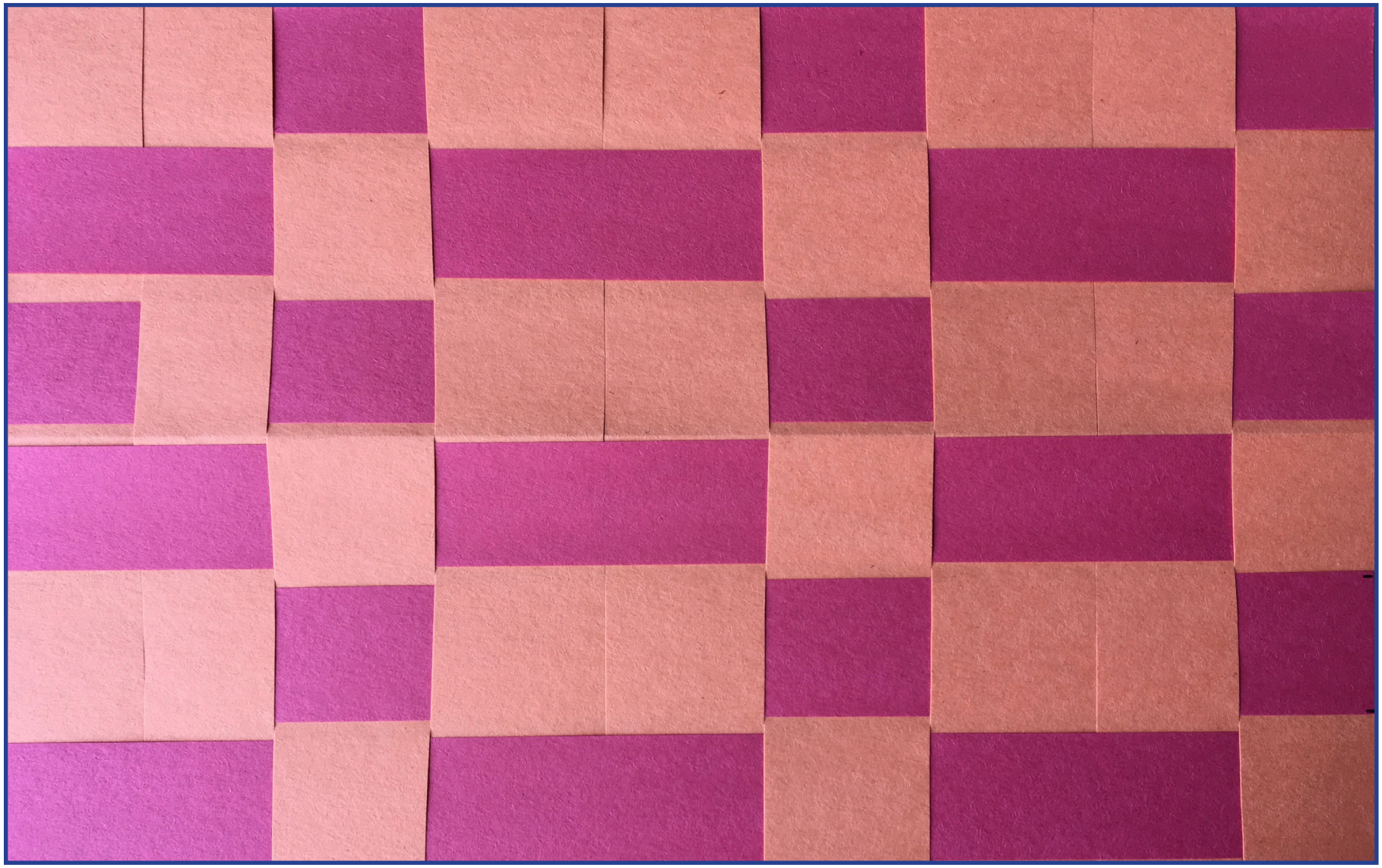


Lesson 5B

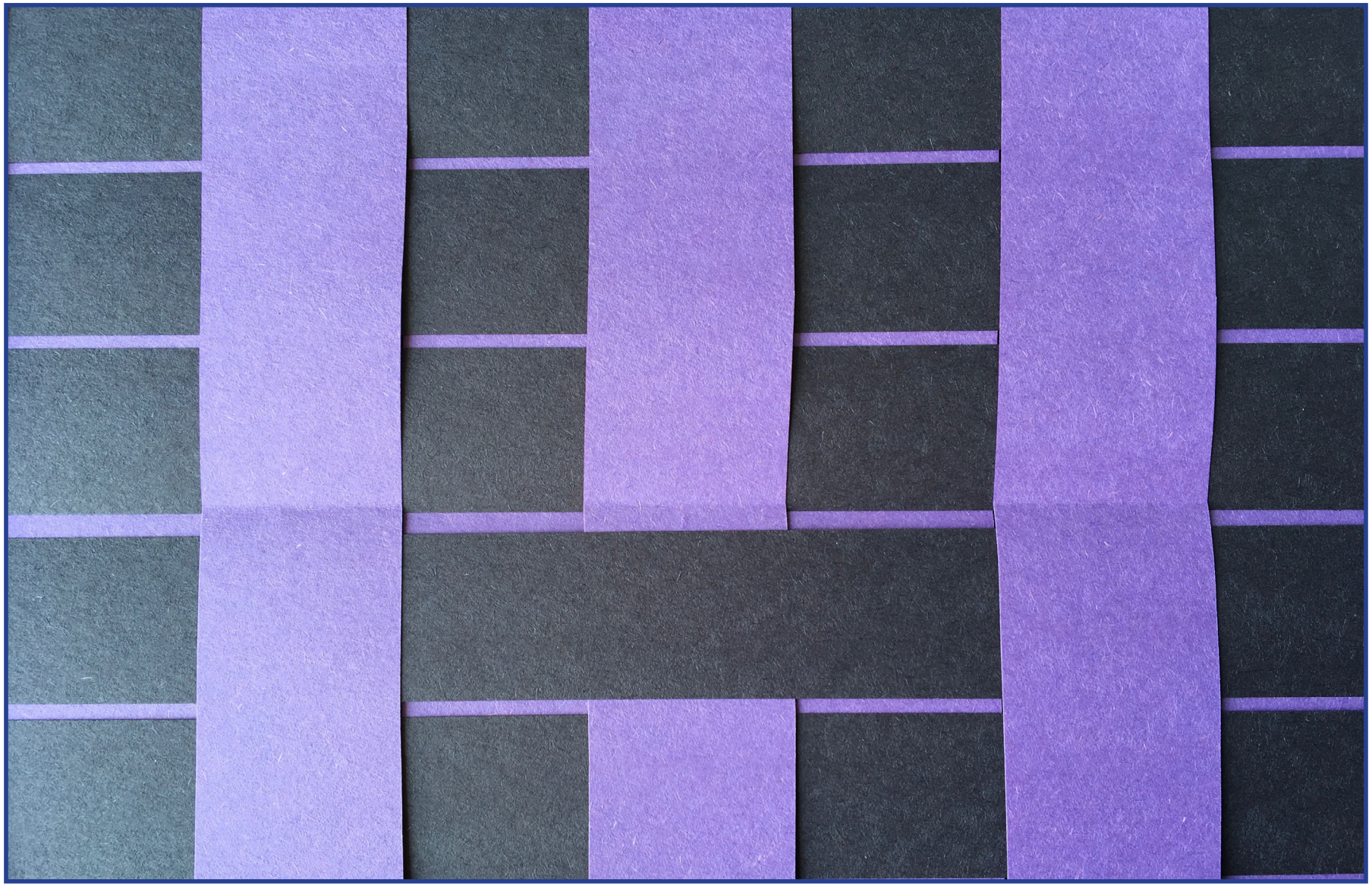
# Pattern Debugging AABB



# Pattern Debugging AABAAB



# Pattern Debugging ABAB (not alternating)



Lesson 6A

# Rocks, Jeans, and Busy Machines

**FOCUS/KEY CONCEPTS**

Students will be able to:

- **Literacy:** summarize narrative text by engaging in interactive sentence writing to identify the beginning, middle and end of the story.
- **Literacy:** recognize that the teacher reads from left to right.
- **Literacy:** understand engineering words and definitions of the words.

**STANDARDS**

- CCSS - ELA: RL.K.2, RF.K.2, W.K.3, SL.K.1, L.K.1.A, L.K.1.F

**MATERIALS**

- **Per student:** ***Summary Worksheet Beginning, Summary Worksheet Middle, & Summary Worksheet End***
- **Per class:** *Rocks, Jeans, and Busy Machines* by Alane and Raymundo Rivera, chart paper

**TEACHER PREPARATION**

- Have the **Summary Worksheets** available to distribute to students

**VOCABULARY**

- **Construction** The act or process of building something
- **Cement** A material that hardens to act as glue
- **Concrete** A hard construction material composed of sand, gravel, cement, and water
- **Machine** A tool or device that is used to help with specific tasks

## SUMMARY OF THE LESSON

In this literacy lesson, students will learn about what engineers do and a field of engineering, construction engineering, as they continue to work through the engineering design process with their basket design. The focus of this lesson is on summarizing narrative text by engaging in interactive sentence writing to identify the beginning, middle and end of a fictional story, *Rocks, Jeans, and Busy Machines: An Engineering Kids Storybook* by Alane and Raymundo Rivera. Reading strategy: summarizing narrative text.

## INTRODUCTION

1. **Tie to engineering challenge.** Explain to students that engineers have constraints. They have to follow plans to make things safe. Engineers design and test their work to make sure that it meets the requirement of the customer. Lastly, they have to communicate their designs clearly. Earlier, Max shared the constraints for his basket design. **Ask:** *What are the constraints Max and Lola gave for the basket?*

2. **Identify where they are in the engineering design process. (Learn)** Remind students that an important part of the engineering design process is learning about the problem and ways to solve the problem. Engineers need to learn about the materials they will use so they can make a design that meets the project criteria.

3. **Activate prior knowledge.** **Ask:** *Have you ever seen a construction site before? Did you see any large machines on the site? What size were they? Do you know what was being built? Tell a partner about what you saw and what they were building.*

## ACTIVITY - Summarizing narrative text

4. **Introduce the book.** Introduce students to the book *Rock Jeans, and Busy Machines*: *An Engineering Kids Storybook*. Show students the cover and tell them that it is a fictional story about a girl Violet and her adventures as an engineer. Explain that, as you read, you want them to pay attention to some of the things Violet does as they are going to continue to think and act like engineers to solve Max and Lola's problem.

5. **Introduce the skill.** **Say:** *After we have finished reading, we will also be working on becoming better readers by practicing our summarizing skills. So you will want to make sure that you are paying careful attention to what Violet is doing in the story.*

   NOTE: It is important for students to be working on their knowledge of sound-symbol correspondences. One way to help with this aspect of their phonemic awareness development is to engage in interactive sentence writing, where students are able to see how the sounds they hear in words can be written down in a sentence.

# Rocks, Jeans, and Busy Machines

This also helps students start to develop ideas about how to summarize narrative text by writing interactive sentences together. After reading this story together, you will help students write three sentences as a group that summarizes the story's beginning, middle and end.

6. **Start Reading.** Read the book. Remember to use some of the things that help their development:
   - Teach new vocabulary at the point of contact, some examples could include machines, building, or concrete
   - Target the reading skill – summarizing the informational text
   - Encourage higher-level thinking and comprehension monitoring by pausing for "teacher think alouds" and asking questions about or discussing the text

7. **Summarize text.** You can re-read the text to help students summarize this narrative text by writing interactive sentences. Have students help you write three sentences as a group that summarize the story's beginning, middle, and end.

   Ask the students for ideas about the beginning, and then use those ideas to come up with a sentence for the group to write. Have students help with the writing by giving you as many of the sounds in the words and letters as they can. Repeat this for the middle and ending of the story to complete the summary. Have students write the sentence on the **Summary Worksheets**.

## CLOSURE

8. **Tie back to engineering challenge.** Remind students that they are working like engineers to help Max and Lola. **Ask:** *What kinds of things did you notice the engineers doing during the story?* Take a variety of answers. **Ask:** *What safety measures did you see?* Take answers. **Ask:** *What can we learn from the book to apply to our design of the baskets?* Take answers. Let the students know that they will next be working on planning their basket designs.

## TEACHER NOTES

Lesson 6A

**ASSESSMENT**

**Pre-Activity Assessment**
Listen to students' responses to the activation of prior knowledge.

**Activity Embedded Assessment**
Review students' summary sentences for the literacy skill.

**Post-Activity Assessment**
Listen for students connections between the story and the work they are doing as engineers.

Lesson 6A

Name_____

## Summary Worksheet Beginning

**Directions:** Write the sentence the class made together for the beginning of the story.

Lesson 6A

Name_____

## Summary Worksheet Middle

**Directions:** Write the sentence the class made together for the middle of the story.

Lesson 6A

Name_____

## Summary Worksheet End

**Directions:** Write the sentence the class made together for the end of the story.


**FOCUS/KEY CONCEPTS**

Students will be able to:

- **Science:** conduct investigations to understand how things work.
- **Engineering:** gather data from tests of an object or tool that can be analyzed to determine if it works as intended.

**STANDARDS**

- CCSS - ELA: SL.K.1
- CCSS - Math: K.CC.A.3, K.CC.B.4, K.CC.B.5, K.CC.C.6, MP6
- NGSS: K-2-ETS1-2, K-2-ETS1-3, P3, P4, P8

**MATERIALS**

- **Per student:** (2) **Prototype #___ Basket Design Plan** sheets
- **Per pair:** basket prototypes from 5B, **Final Letter to Max and Lola** sheet, glue stick
- **Per class:** second **Email from Max** (intro lesson), (2) testing stations: large plastic tub, cup of water, eyedropper or pipette, and bag of 50+ medium-sized rocks (river rocks) for testing, chart paper, **Thank You Email from Max and Lola**

- **For redesign**: all materials from 5B and 6B

**TEACHER PREPARATION**

- Set up 2 testing stations: large plastic tub, cup of water, eyedropper OR pipette, and bag of 50 rocks for testing
- Prepare class testing chart (ex: step 7)
- Have students' baskets available for testing
- Prepare **Prototype #__**

# Testing Baskets

## SUMMARY OF THE LESSON

In this STEM+C lesson, students will continue to work through the engineering design process as they test the paper baskets that they created in Lesson 5B. An important part of the engineering design process is finding out when their designs work AND when they don't work so it is important for students to have a chance to test their baskets when wet and when dry, before reflecting, redesigning and retesting their baskets. After testing has been completed, students will use what they learned and work on their communication skills to write letters to Max and Lola, making recommendations for their basket design.

## INTRODUCTION

1. **Tie to engineering challenge.** Re-read the second **Email from Max**. Review the criteria of the design challenge.

2. **Identify where they are in the engineering design process. (Test)** Remind students that an important part of the engineering design process is finding out when their designs work AND when they do not work. Prepare them for the idea that their baskets may tear during the testing process, and that if they do, they should think like engineers to try to understand what went wrong and how they could improve on their designs. Reinforce that testing to the point of failure is an important part of an engineer's job.

## ACTIVITY - Testing baskets

3. **Introduce the activity.** Give student pairs their baskets completed in Lesson 5B. Students will test their designs. Tell them that these tests will be similar to the ones they did in Lesson 3, except they will now put 30 rocks in the baskets, since they are thicker than the single sheets of paper tested earlier. If the 30 rocks hold for the dry and wet test, they will have the chance to add more rocks, up to 50, to further test the strength of their baskets. Hand out one copy of the **Prototype # __ Basket Design Plan** to each student. Have students fill in a "1" for the blank on the design plan.

4. **Dry testing.** One student holds the basket by the handle over the plastic bucket, while the second student carefully places 30 rocks in center of the basket. Students count to 10, then set the basket down and inspect it for signs of tears. Students should record how many rocks their basket held.

5. **Wet testing.** Again, one student holds the basket by the handle over the plastic bin while the other student puts three pipettes full of water in the center of the basket. The second student carefully places 30 rocks in the basket. Students count to 10. If basket is still strong, continue to test its strength by adding up to 20 more rocks to the center (for a total of 50 rocks). Students should record how many rocks their basket held.

6. **Reflect and record.** Have students individually complete the rest of the **Prototype # __ Basket Design Plan**. They should compare their answers with their partner.

# Testing Baskets

7. **Share.** Allow students to share the results of their tests with the class. Create a table to record what materials each pair used and which design goals were met. Also **ask:** *What about your design worked well? What would you change if you did it again?*
   NOTE: An example of what the table for your chart could look like is below. The first row is an example of the information to be collected from the students about their designs. Remind students that the base is always Lola's template.

| strip material | pattern | # of rocks held when dry | # of rocks held when wet | looks nice |
|---|---|---|---|---|
| wax paper | AABAAB | 23 | 14 | yes |
| ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... |

   After all pairs have shared and the class table is complete, help students notice patterns in the data that may help them make good design desicisions on their redesign.

8. **Redesign.** Allow students to redo their plan, try, and test phases on a new design. Have students complete the **Prototype # __ Basket Design Plan**. Have students fill in a "2" for the blank on the Design Plan.

9. **Complete letter to Max and Lola.** After testing on all versions of prototypes is complete, have pairs work together to complete the **Final Letter to Max and Lola**.
   NOTE: Ensure that you communicate that the physical basket they make is not the final solution. Although students do need the physical baskets so that they can test the baskets to make sure they work, Max and Lola need for students to share their final plans with them. The final plan should give directions on how to make the baskets – materials and steps – so they can tell people who visit their rock collection how to make a basket just like theirs when they go home. The **Final Letter to Max and Lola** scaffolds the directions.

## CLOSURE

10. **Share final design.** Have students share with their classmates the design they ultimately chose and why they chose that basket design.
11. **Read thank you email from Max.** After students have had a chance to complete their letter to Max and Lola and share their recommendations with the class, read the thank you letter from their client, Max.


**Basket Design Plan** (2 per student)
- Prepare **Final Letter to Max and Lola** (1 per pair)
- Prepare copy of **Thank You Email from Max and Lola**

**VOCABULARY**
- **Test** A method to check the quality, reliability, or performance of something

**ASSESSMENT**

**Pre-Activity Assessment**
Ask students how they think their baskets will do during the wet and dry tests.

**Activity Embedded Assessment**
Listen to teams as they test their baskets.
Review the class chart after testing.

**Post-Activity Assessment**
Review **Basket Plan** revisions and **Final Letter to Max and Lola**

**TEACHER NOTES**

Lesson 6B

Name_____

# Prototype # ____ Basket Design Plan

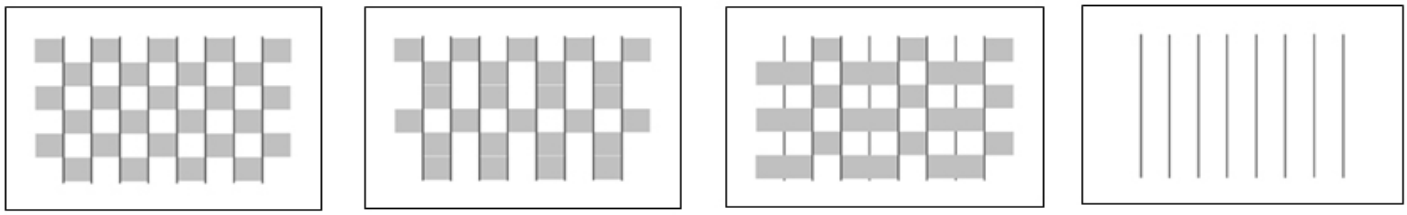
| Test | Do you think it will hold 30 rocks? (circle one) | # of rocks basket held | Describe how the basket looks after testing. (circle one) |
|---|---|---|---|
| 1. dry rocks | yes no | | There was no change. Some tears. It broke. |
| 2. wet rocks | yes no | | There was no change. Some tears. It broke. |

3. Should Max and Lola use your basket design? yes no

4. The basket strips Max and Lola should use are:

- ☐ A. copy paper
- ☐ B. construction paper
- ☐ C. waxed paper
- ☐ D. tissue paper
- ☐ E. paper towel

5. Circle the pattern max and Lola should use for their basket instructions.



Lesson 6B

Name_____

# Final Letter to Max and Lola

Dear Max and Lola,

Here are the **TEST RESULTS** for our final basket design:

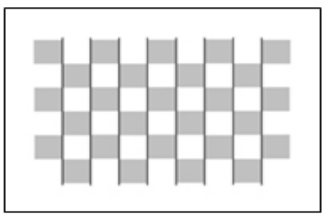
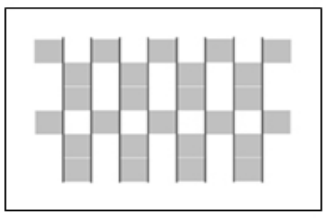
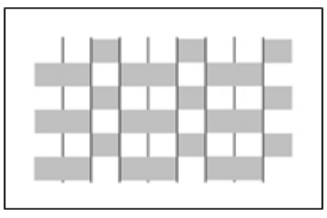
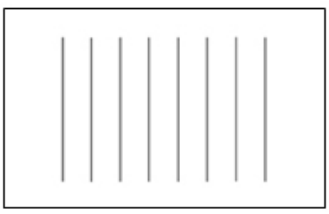
| **Test** | **# of rocks basket held** | **Describe how the basket looks after testing.** (circle one) | | |
|---|---|---|---|---|
| 1. dry rocks | | There was no change. | Some tears. | It broke. |
| 2. wet rocks | | There was no change. | Some tears. | It broke. |

Our design uses this paper for the **STRIPS:**

glue paper here

glue paper here

Our design uses this **PATTERN** for the basket (circle one):

We think that you **SHOULD** **SHOULD NOT** use our basket design.
(circle one)

Signed, _____ and _____

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Reply All

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Related

Follow Up

From: Max_the_collector@gmail.com
To: StudentEngineers@gmail.com
CC:
Subject: Thank you from Max and Lola

Dear Students,

Thank you for all of your hard work on designing and testing the paper baskets that can be used to collect rocks. We received your letters. We really liked all of the different prototypes you and your classmates designed. We look forward to sharing these designs with fellow rock collecting friends. Good job engineers!

These paper basket designs will be a hit at the local nature center. We are so excited to have a prototype that other rock collectors can use to make their own baskets. Thank you for helping us to create a basket that has nice patterns and is able to carry both wet and dry rocks.

Thank you for all of your hard work!

Max and Lola