Tinkering Tool Kit Lesson 1

Lesson Title: All Aboard!

Grade Level: 4th

Lesson Length: 1hr

Lesson Objective(s): Students will be introduced to project goals, safety expectations, Design Thinking process and will become familiar with the contents of Tinkering Toolkit through a collaborative learning activity.

Essential Question:

- What can we learn from creating collaboratively?

Key Vocabulary

- **Blood Bubble,** *n.* - The area around the tools where close contact is most dangerous. Every tool has a blood bubble.
- **Collaborative,** *adj.* - Joining with others in attentive participation in an activity of imagining, exploring, and/or making.
- **Design,** *v.* - Application of creativity to planning the optimal solution to a given problem and communication of that plan to others
- **Design Thinking,** *n.* A non-linear process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. Involving five phases—Empathize, Define, Ideate, Prototype and Test—it is most useful to tackle problems that are ill-defined or unknown.

Materials:

- Tinkering Toolkit
- TTK Booklet
- P.S.ARTS kit

Anchor Artist/Scientist: William Hunter Dammond

Instructional Sequence:

- **Intro (15min)** *(safety practices, preview, check for prior knowledge, & set tone)*
    - Each week we will be learning about a Black artist or engineer whose contributions have helped mold our modern sciences and arts landscapes.
        - Anchor Artist**:** Willam Hunter Dammond
            - Graduated from University of Pittsburgh in 1893 as one of the few Black civil engineers in the nation.

- In 1903 he received a patent for an electric track circuit signaling system, and later received a second patent for a “Safety System for Operating Railroads”.
- An engineer who worked in many fields, including bridge design, steel manufacturing, and railroads.
- In 1949, the *Chicago Defender*, a national Black-owned newspaper, featured Dammond and his fight to receive credit for his work.
    - Why did Dammond have to fight to receive proper credit for his work?

- **Project Introduction**
    - This project will use the reDiscover Tinkering Toolkit to learn different techniques to design and build a class train. Using Design Thinking, you will design and build your own individual train car based on a problem you would like to solve in your community.
        - Where have you seen trains before? What is their purpose?
    - **Design Thinking**: Empathize, Define, Ideate, Prototype, Testing, (Share).
        - **These stages are different *modes* which contribute to the entire design project, rather than sequential steps**. You will be practicing each step throughout the process multiple times as you experiment.
- **Classroom Expectations**
    - William Hunter Dammond’s Safety System for Operating Railroads was created to make operating trains as safe as possible, and was considered “life saving”. Before we begin tinkering, we will create our own classroom Safety System to follow throughout our project. Use the *TTK Booklet* as a guide:
        - Create a class “Safety System”, which will act as the classroom safety agreements. Be sure the agreements are displayed prominently in the classroom.
        - Practice attention signals, such as “tools down, eyes up”. Teacher can also assign or create classroom jobs such as “safety inspector”, “tool tracker”, etc.
        - Review expectations for our tinkering “work spaces”.
        - Clean up routine

- **Guided Practice (35min)** *(model, explore, & engage)*
    - **Tool Exploration -** What’s in our kit?
        - Use the *TTK Booklet* to go through each tool one at a time as a class. Emphasize how it’s used and the safety expectations. (*Teaching tip*: there will be a lot of excitement about exploring the tools so this will require guided instruction. It will also be the first opportunity to practice the classroom agreements). Students will be tested on what they learned in the next activity.
    - **Team Building Activity - Tool Carousel**

        - With the people at your table, rotate to different stations set up around the classroom to recall the function and safety expectations for each tool listed in the *TTK Booklet*.
            - Each team starts at a station in the classroom and has 2min to work together to answer the question(s) pertaining to that tool. Example: “Where is the blood bubble for this tool? What are the 5 steps of using a glue gun? The end of every glue gun lesson should include ____.”
                - Station 1: Canary Cutter
                - Station 2: Hot Glue Gun
                - Station 3: Pliers & Snips
                - Station 4: Screw Driver
                - Station 5: Attachment Techniques
                - Station 6: Stages of Design Thinking & Creative Reuse
            - At the end of 2min teams rotate to the next station until all teams visit each station.
            - Return to seats and review answers as a class.

- **Reflection (10min)** *(recap, deepen, check for understanding)*
    - Think/Pair/Share: Why was it important to work as a team during the Tool Carousel exercise?
    - Why is the creation of the safety systems an important part of William Hunter Dammond’s legacy?
    - Check for understanding:
        - Where is our class Safety System displayed in the classroom?
        - What are the elements of Design Thinking?

Differentiation:

- Students can reference the *TTK Booklet* or a personal design journal to assist in Tool Carousel activity.

Assessment:

Students demonstrate their understanding of how to use tools through a group share, or with writing prompts.

Teacher Takeaways:

- Where can Design Thinking apply outside of the tinkering context?

Classroom Resources:

- Information on William Hunter Dammond: https://blog.innovation.pitt.edu/william-hunter-dammond-a-man-of-firsts
- TTK Booklet: https://drive.google.com/drive/folders/1Wn6WalateM-TmfmFNoP1hrwgOKMLPtr1

Content Standard(s)

CCSS.ELA-LITERACY.RI.4.3

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CCSS.ELA-LITERACY.SL.4.4
Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.
CCSS.Math.Content.4.MD.A.3
Apply the area and perimeter formulas for rectangles in real world and mathematical problems. *For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor*.

NGSS
3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-3**:** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

VAPA Standards
4.VA:Cr1.1: Brainstorm individual and collaborative approaches to a creative art or design problem.
4.VA:Cr2.2: When making works of art, utilize and care for materials, tools, and equipment in a manner that prevents danger to oneself and others.
4.VA:Re7.2: Analyze components in visual imagery that convey messages.

Social Justice Standards:
JU.3-5.14: I know that life is easier for some people and harder for others based on who they are and where they were born.
JU.3-5.15**:** I know about the actions of people and groups who have worked throughout history to bring more justice and fairness to the world.

Social Emotional/CASEL connections:
SELF MANAGEMENT: setting personal and collective goals
SELF MANAGEMENT: using planning and organizational skills
RESPONSIBLE DECISION-MAKING: demonstrating curiosity and open-mindedness

Tinkering Tool Kit Lesson 2

Lesson Title: Let's Connect - Making Interlocking Slots

Grade Level: 4th

Lesson Length: 1hr

Lesson Objective(s): Students will explore cutting techniques and create interlocking slots with canary cutters, scissors and snips.

Essential Question:

- What factors prevent or encourage people to take creative risks?

Key Vocabulary:

- **Design Thinking,** *n.* - A non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test.
- **Shape**, *n.* - A closed space made when a line connects to itself.
- **Organic shapes,** *adj.* - Often curvilinear in appearance, that are similar to those found in nature such as plants, animals, and rocks.
- **Geometric shapes,** *adj.* - Any shapes based on math principles, such as a square, circle, and triangle.
- **Interlocking Slots,** *n.* - An attachment technique done by cutting slots into two pieces and sliding them to fit together. Also known as "slot construction"
- **Slit,** *n.* - A long, narrow cut or opening.
- **Wedge,** *n.* - a piece of wood, metal, or some other material having one thick end and tapering to a thin edge, that is driven between two objects or parts of an object to secure or separate them.

Materials:

- Design Thinking student resource
- canary cutter, scissors, snips, pencil, tape measure and a straight edge
- Cardboard - single ply, clean and smooth
- P.S.ARTS kit

Safety Protection:

- Gloves

Anchor Artist/Scientist: Romare Bearden

Preparation

- **Before you start**
    - Prepare a stock of clean panels of cardboard
        - Break down boxes at the folds into 12 panels, discarding any that have major rips or other damage.
        - Remove as much tape as possible without damaging the panels. Panels that are at least 8" wide and no longer than 24" are easiest to work with.

Instructional Sequence:

- **Intro** *(safety practices, preview, check for prior knowledge, & set tone)*
    - Safety Practices
        - At the start of class, teacher will go over the safety agreements they set from Lesson 1. Today, we will explore Canary Cutters & Scissors.
    - Review **Design Thinking:** Empathize, Define, **Ideate, Prototype, Test**, (Share).
    - Anchor Artist/Engineer: Romare Bearden
        - (1911-1988) An important artist from the 20th Century that depicted the African American culture and experiences in creative and thought-provoking ways through Abstract and Cubist style paintings in oil and watercolor
        - Source: https://www.biography.com/artist/romare-bearden
    - **Lesson Review** ***(s****et objective)*
        - Our goal today is to connect pieces of cardboard without using any glue or tape. How might we do this?
        - Introduce Interlocking Slots
            - Interlocking Slots is a method of Creative Construction. It is a collection of parts that can be used to build, unbuild, and rebuild.
            - It is also a Cardboard connection technique that can be used to put parts together without any adhesives.
            - Think pair share: How are these parts connected? What tools can we use to make the slits, slots, and wedges in our parts?

- **Guided Practice** *(model, explore, & engage)*
    - **Tool Exploration - Canary Cutters**
        - Show introductory video: Cutting with canary cutter (2:26). Identify how to cut straight lines, curves, and geometric shapes.
        - Let's try it! Reference pg.6 of your TTK Booklet to review the safety and use of canary cutters:
            - Teacher models: Safety procedures, Operation, and Method 1 & 2.
            - You can feel that it's not too sharp, but this blade does the most damage when it's moving!
        - Problem: poor Canary Cutter posture, grip, and cutting motion.
        - Solution: Break down the elements of good Canary Cutter use, practice them together:
            1. Mark your cut line, ideally with a straight edge
            2. Stand up

3. Align the cardboard panel so the line to cut is 1" off the edge of the table and parallel to the table edge. Working at the corner of a table is best.
4. Position your body so you can clamp the cardboard panel with your non-dominant hand down onto the table. You may need to move yourself or your cardboard to get into position
5. Grasp the Canary Cutter with a knife grip, touching only the yellow handle
6. Start at the far edge of the cut line. If this is too much of a reach, move. your cardboard to a lower table or use a chair.
7. With the cutter at a 45-degree angle, saw back and forth while you pull the knife towards you. Start gently and increase pressure as needed. Use the middle section of the knife, be sure that the tip of the cutter does not come out of the groove
8. When you get close to the end of your cut line and the piece is about to fall either a) rip it off or b) trim last bit with scissors or c) ask a helper to hold the piece in place, keeping their hands far from the cutter
9. Put the cutter down before bending to retrieve the piece if it has fallen to the ground

- **Activity: Find & Seek Shapes** *(independent practice)*
  - Project an image of Romare Bearden's painting *The Block*. Identify 3 geometric and 3 organic shapes from the painting and sketch them in your design journal: https://www.metmuseum.org/art/collection/search/481891
  - **https://www.richlandlibrary.com/sites/default/files/inline-images/hb_1978.61.1-6.jpg**
  - **Guided Practice**
    - Give each student a sheet of cardboard. Cut this rectangle into pieces, either cutting strips off the edge of the cardboard panel or cutting the panel in half, repeatedly. Aim for the first use of Canary Cutters to be straight lines **only** that connect two edges of the panel, making either a rectangle or a triangle. Save awl holes and interior cuts until after this basic technique is mastered
    - Extension: Use the large pieces created for slot construction.
      - 2-4 slot wedges or slits to each shape. For single ply cardboard: a wider slot, or a slot made by cutting 2 parallel lines and removing the piece, will make for a more successful slot construction.
    - Advanced: Inscribe a circle or irregular curved shape that completely fills one of your pieces, cut it out using scissors, discard the scraps
    - Using the P.S.ARTS kit, color or add textures/patterns to your construction parts
  - **Independent Practice**

        - With a partner, experiment with your new interlocking pieces.
        - **Instructional Menu Choices (Differentiation)**
            - Build the tallest structure possible using 10 slots;
            - Build the longest construction possible using 10 shapes;
            - Build one that looks like an animal;
            - Build a structure that looks like a tree;
            - Build a structure where every piece connects to at least two other shapes.
    - Clean up**:** Be sure to safely store your pieces, as we will use them for Lesson 3.

- **Reflection** *(recap, deepen, check for understanding)*
    - How was Romare Bearden's use of improvisation similar to our building process? How does it relate to **Design Thinking**?
      Check for Understanding:
    - What are the best techniques for cutting shapes out of cardboard safely?
    - How can we take 2D shapes from an image and turn them into self-standing, cooperative forms?

Differentiation:

- Teachers can prepare physical examples of interlocking slot pieces ahead of time to showcase their anatomy.
- Print slides if printers are accessible.
- If teachers don't have screens to project the demo videos onto, they can learn to use the tool and demo them live with their students.
- Tools - using scissors vs. snips to make slits and wedges
- Technique - Cutting parallel lines vs. triangles for slits and wedges

Assessment:

Students successfully create pieces that fit and stick together and demonstrate an understanding of interlocking slot mechanisms by engaging with the challenge prompts.

Teacher Takeaways:

- Pro-tip reference sheet for teachers

Classroom Resources:

- Lesson Slides
- Pro Tips Sheet

Content Standard(s)

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Tinkering Tool Kit Lesson 3

Lesson Title: Visually Inspired Inventing & Mixing Media

Grade Level: 4th

Lesson Length: 1hr

Lesson Objective(s): Students will become familiar with different types of adhesives including tape and glues, and create a new structure from recycled materials.

Essential Question:

- Why do we practice Creative Reuse?

Key Vocabulary:

- **Brainstorming,** *n.* - A discussion (usually in groups) to produce ideas or solve problems
- **Adhesive,** *n.* - A substance used for sticking objects or materials together.
- **Troubleshooting,** *v.* - To trace issues or problems in making methods and find ways to fix them.
- **Upcycle,** *v.* - reuse (discarded objects or material) in such a way as to create a product of higher quality or value than the original.
- **Creative Reuse**, *v.* - To use something in a creative way to make something new, or fix something old.

Materials:

- Hot glue
- Glue stick
- Elmer's glue
- Tape
- Collection of materials to be upcycled, including materials included in their kit (wire, skewers, scrap fabric/mylar, wire)
- Cardboard
- TTK Tools: Canary cutter, scissors
- Design Journal

Safety Protection:

- Gloves
- Safety Goggles

Anchor Artist/Scientist: Noah Purifoy

Instructional Sequence:

- **Intro** *(safety practices, preview, check for prior knowledge, & set tone)*
    - **Anchor Artist/Engineer:** Noah Purifoy
        - 1917 - 2004. Born in Snow Hill, Alabama. Lived and worked most of his life in LA and Joshua Tree.

        - Purifoy was crafty with wood/construction and incorporated using junk/trash in his work - a great example of **Creative Reuse & Upcycling!**
        - Being surrounded by trash as a liberating concept
        - Using things that have another presence or another life/existence.
        - Became founding director of Watts Towers Art Center, shorty after the Watts Riots of 1965 occured
        - Riots left Watts in rubble and debris, Purifoy and fellow artist Judson Powell collected tons of trash from the riots and created exhibit called 66 Signs of Neon
        - Creation out of destruction/war. Making art work inspired by rebellion/tragedy, not to memorialize the events, but as a means of conversation.
        - His work lives in the Noah Purifoy Outdoor Desert Art Museum in Joshua Tree.
- **Lesson Review**
    - Today we will experiment with the different types of adhesives available in our TTK: Hot glue, tape, glue stick, and liquid glue.
        - **Design Thinking**: Why experiment with different adhesives? Today's lesson will help you familiarize with the various adhesives available to you during the Prototype and Testing phases of building your train car.

- **Guided Practice** *(model, explore, & engage)*
    - Tool Training - Adhesives.
        - Review Adhesives anchor chart of drying times and compatible materials (details of anchor chart under "Classroom Resources").
    - Working with Hot glue
        - First, we need to set up our work space: Setting up your Workspace (1:52)
        - Who can recall the safety practices of using a hot glue gun from Lesson 1? Use the TTK guide to review and play this video: How to use a Glue Gun (4min)
            - Highlights from the video:
                - Prepare our workspaces to protect furniture and ourselves
                - Set a "home" for the hot glue using a piece of cardboard
                - Covering our tables/workstations with a layer of cardboard
                - Using gloves when using the hot glue gun
        - How much hot glue to use (1:54)

    - Activity: Visually-Inspired Inventing
        - Setting the context: Have you ever been "cloud watching"? When we cloud watch, we associate familiar images with the clouds we see. For example, what comes to mind when you see these clouds: https://www.amusingplanet.com/2012/04/clouds-that-look-like-things.html , Jamboard

- We'll do something similar today by creating new structures and reinterpreting them using our imagination. We will use our interlocking shapes from Lesson 2, adhesives, and optional recycled materials.
    - First, let's make a new structure. Take out the 3 interlocking shapes you made from Lesson 2. With two other people, combine your shapes together to make an abstract structure.
    - Next, observe your new structure with your group - can you associate it with another image? Sketch your ideas in your Design Journal. Brainstorm what kind of recycled materials you might use to build the new structure.
    - Lastly, as a group, tape and glue together your assemblage or recreate one of your sketches using recycled materials and adhesives. **Make sure to use all four adhesives: hot glue, white glue, glue stick, and tape.**

Examples of each step:

- **Reflection** *(recap, deepen, check for understanding)*
    - How does Noah's Purifoy's work relate to creative reuse? What are some ways you've practiced creative reuse at home?

Differentiation:

- Teachers can demonstrate how a combination of different slot pieces can inspire different sketches based on the perspective from which they are viewing the abstract sculpture. This can be done by providing a demo of sketching products quickly from their visual inspiration.

Assessment:

Students create an artwork or product that successfully uses adhesives so that parts stay intact. Students' success is also based on their ability to troubleshoot through the different adhesives and test out which ones work best for certain materials.

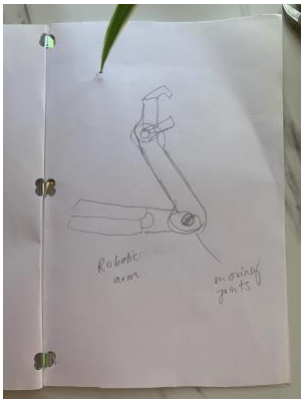
Teacher Takeaways:

- Discuss the significance of the Watts Towers to the Watts community and how art can communicate a message.

Classroom Resources:

- Have the following prepared on an anchor chart:
    - **Adhesives will have different drying times.**
        - Tape is instant.
        - Hot glue takes about 60 seconds to dry.
        - Gluestick takes a few minutes.
        - Liquid glue takes much longer, but might work better in the long run if students are patient.
    - **Adhesives will work best with certain types of materials.**
        - Glue sticks work best with thin papery materials, maybe cardboard
        - Hot Glue works well with a wide range of materials, including metals, plastics, and papers, but be mindful that it can get hot enough to melt fine, thin plastics.
        - Tape works with anything if used strategically.
        - Liquid glue also works with a wide range of materials, but it takes the most drying time.
- Tiny Technique videos above
- Jamboard
- Creative Reuse image:

- More examples for Visually-Inspired Inventing activity:



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Social Emotional/CASEL connections:

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RESPONSIBLE DECISION-MAKING: demonstrating curiosity and open-mindedness

Tinkering Tool Kit Lesson 4

Lesson Title: Getting on track

Grade Level: 4th

Lesson Length: 1hr

Lesson Objective: Students will begin the train car design process with the first two steps of Design Thinking: Empathize & Define. Students will create the Deck, Trucks, and Wheels for their chassis.

Essential Question:

- How do artists and designers learn from trial and error? (VAPA Cr.2.1)

Key Vocabulary:

- **Problem Statement,** n. - Concise description of design problems.
- **Chassis,** *n.* - Deck, Trucks, Axles, and Wheels
- **Corrugation,** *n.* - The wavy paper inside cardboard that helps keep its structure.
- **Flutes,** *n.* - The long thin holes along the corrugation in corrugated cardboard.
- **Cut List,** *n.* - A listing of all the parts that will be required to construct a project.
- **Trucks,** *n.* - An undercarriage with four to six wheels pivoted beneath the end of a railroad car.
- **Area** - length x width

Materials:

- Design Journal or graphing paper.
- Single ply Cardboard
- Precut cardboard wheels
- Tape Measure and a ruler/straight edge
- Tape + the hole in the orange tape is perfect for tracing a circle
- Screwdriver - Awl tool
- Canary Cutter
- Scissors
- Pencil
- Brass Brads
- Slide Deck

Safety Protection

- Gloves
- Safety Goggles

Anchor Artist/Engineer: Sydney Hamilton

Instructional Sequence:

- **Intro** *(safety practices, preview, check for prior knowledge, & set tone)*

- **Sydney Hamilton**
  - ”You don’t have to have it all figured out today. Just continue to be curious, determined, and hopeful because you will be the one to make that discovery, you are going to solve that ‘impossible’ problem and you are going to change the world. You are brilliant.” - Sydney Hamilton
  - Hamilton is a Structure Stress Manager at Boeing in Long Beach, CA who supports the development of aerospace structures like satellites that make it possible to use Wi-Fi, GPS, and building & repairing airplanes.
  - She believes that the diversity of people, thoughts, and experiences are at the core of developing new groundbreaking innovations. She especially loves to support young women of color pursue careers in the STEM field.
  - Short video on Sydney’s background as an engineer for Boeing and her process (3min) https://www.ifthencollection.org/sydney
- **Lesson review:** Students will begin the design process with the first two steps of **Design Thinking:** Empathize & Define. Students will create the Deck, Trucks, and Wheels for their chassis.

- **Guided Practice**
  - Let’s start with the first two steps in the **Design Thinking** process - Empathize & Define.
    - Empathy: Research your community’s needs. Gather information and evidence by consulting with community members & classmates.
    - Define: State your community’s needs. Analyze the information you gathered from your research and create a problem statement.
      - Problem Statement sentence frame: “My community needs____ because_____”
  - Building the chassis: Use the Slide Deck to walk students through the process of creating each of the following chassis components.
    - Intro to Chassis
      - The chassis is the bottom portion of the train car that serves as the foundation upon which the train car sits. The parts of a chassis includes the: trucks, wheels, axles, deck and couplers. Today, we will start with building the Trucks and the Wheels.
        - Show example of completed train car chassis, complete trucks and couplers.
      - Cardboard: students can bring single ply cardboard from home for this project, any type of standard shipping box (ex:Amazon) will do. We will use the corrugation of the cardboard when we attach our axles. Be sure the cardboard you bring from home is large enough to cut all the pieces we need.
      - Cut list for Trucks, Wheels & Deck:
        - **DECK**: One 4x12 piece of single ply cardboard.
        - **TRUCKS**: Two 3x9 pieces of corrugated cardboard. There will be two Trucks per train car.

        - **WHEELS**: One 4x12 piece of single ply cardboard to cut out 8 wheels. You will use TTK tape roll to measure the diameter of wheels.
    - Building the Deck, Trucks, and Wheels
        - **Cut the Deck -** put aside for Lesson 5.
            - **Find the Area of your Deck:** Using measuring tape, measure length and width of chassis to find the **Area** of the chassis. Record in Design Journal. All train cars should have the same area.
        - **Building the Trucks**:
            - Using the cardboard from home, measure and cut the pieces for the Trucks. *Pro-tip: follow the natural flutes of the cardboard to draw straight lines when measuring.* When holding the piece horizontally, the flutes of the cardboard should be vertical (illustration on pg.6 of slide deck) so the axles (skewers) will pass through the corrugation when attaching the wheels.
            - With a ruler and pencil, measure four vertical lines on the Truck pieces. (measurements in slide deck) Score lines with your canary cutter. *Note: Use of a sacrificial piece of cardboard when poking holes and scoring.*
            - Fold the cardboard strip along the scored lines to create a box (with a 1” overlap that you can glue down to help stabilize the structure). The box/truck will be open on two sides. Do not secure with tape or glue yet--we will do that in the next lesson.
            - Pierce a hole in the center of the <u>right square</u> of each piece.
        - **Building the Wheels**:
            - Using the roll of tape that is in your Tinkering Toolkit, draw out eight (8) circles using the inner diameter of the roll. (Angle the pen or pencil inside of the tape roll to trace a good circle.) Lay them out as you see in the slide deck.
            - Cut out the wheels. First roughly with the Canary Cutter and then precisely with scissors. You can cut across a wide section with the scissors first, and then trim precisely instead of trying to do it all in one go.
            - Visually find the center of each wheel and, using an awl or screwdriver, pierce the center of each wheel. <u>Note: Place an extra piece of cardboard under the wheels to protect your table surface.</u>
    - Clean up - store loose pieces in TTK bag.

- **Reflection** *(recap, deepen, check for understanding)*
    - Journal Reflection: How will your design represent the solution to your Problem Statement?

- Group Share out: Think back to the video about Sydney Hamilton - how is her approach similar to the Design Thinking process?

Differentiation:

- Slides are available for visual learners
- Diagram can be printed as a guide/cut list
- Teachers can create a physical finished train car for students to analyze, take measurements from, and recreate in their own ways.

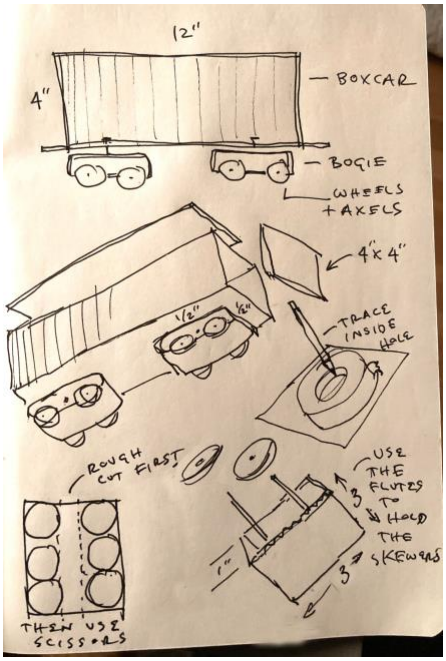
Assessment:

Students successfully cut out 8 wheels and build 2 trucks out of cardboard using the tools safely. If there were any injuries or challenges during the process, students learn to correct their errors to prevent them from happening again in the future.

Teacher Takeaways: Calculate the Area of other found objects or familiar spaces. What's the area of the surface of your desk, white board, basketball court?

Classroom Resources:

- Slide Deck
- https://ifthenexhibit.org/ambassador/B-01/
- Corrugation and Flutes
- Diagram of chassis:



- Train Anatomy:

- Truck is the assembly that retains the axles that holds the wheels
- Wheels, 4 wheels per truck

- There are 2 trucks per train car
- Deck. The platform that the trucks are attached to.
- train car Sides
- train car Ends
- train car Roof
- Coupler
- Handbrake
- Doors
- Ladder
- Track

Content Standard(s)

CCSS.ELA-LITERACY.RI.4.3

Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

CCSS.ELA-LITERACY.SL.4.4

Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

CCSS.Math.Content.4.MD.A.3

Apply the area and perimeter formulas for rectangles in real world and mathematical problems. *For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor*.

NGSS

3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

VAPA Standards

4.VA:Cr1.1: Brainstorm individual and collaborative approaches to a creative art or design problem.

4.VA:Cr2.2: When making works of art, utilize and care for materials, tools, and equipment in a manner that prevents danger to oneself and others.

4.VA:Re7.2: Analyze components in visual imagery that convey messages.

Social Justice Standards:

JU.3-5.14: I know that life is easier for some people and harder for others based on who they are and where they were born.

JU.3-5.15: I know about the actions of people and groups who have worked throughout history to bring more justice and fairness to the world.

Social Emotional/CASEL connections:

SELF MANAGEMENT: setting personal and collective goals

SELF MANAGEMENT: using planning and organizational skills

Tinkering Tool Kit Lesson 5

Lesson Title: Building your train car

Grade Level: 4th

Lesson Length: 1hr

Lesson Objective: Using their Problem Statements, students will move on to the Ideate phase of the Design Thinking process. Students will finish our chassis by attaching our wheels to trucks, and finish by attaching completed trucks to deck.

Essential Question:

- How can art help solve problems in our communities?
- How do objects, places, and design shape lives and communities? (VAPA Cr.2.3)

Key Vocabulary:

Deck, *n.* - In the context of a train car, the deck is a platform built above the wheels and axles where passengers and cargo are transported.

Wheel and Axle, *n.* - A simple machine consisting of a round disc (wheel) with a rod through the center of it (axle) that rotate at the same rate.

Materials

- Cardboard, single ply, 20” x 20”
- Ruler or straightedge (not included)
- Canary Cutter
- Awl/Screwdriver
- Hot Glue Gun + Glue Sticks
- Brass Brads
- Tape Measure
- Bamboo Skewers
- Pencil
- Markers
- Tape
- Snips

Safety Protection

- Gloves
- Safety Goggles

Anchor Artist/Engineer/Activist: A. Philip Randolph

Instructional Sequence:

- **Intro** *(safety practices, preview, check for prior knowledge, & set tone)*
    - Anchor activist: A. Philip Randolph

        - A. Philip Randolph was an activist, labor unionist, and social politician, widely known for his work in support of the Black working-class in the U.S.
        - Randolph served as the first President of The Brotherhood of Sleeping Car Porters (BSCP), a group created by the all-black service staff of the Pullman sleeping cars. He led an arduous campaign to organize the Pullman porters, which resulted in the certification of the BSCP as the exclusive collective bargaining agent of the Pullman porters in 1935.
        - As one of the original organizers of the March on Washington, Randolph's call for civil disobedience to end segregation in the armed forces helped convince the next generation of civil rights activists that nonviolent protests and mass demonstrations were the best way to mobilize public pressure. The movement recognized his role by naming him the chair of the 1963 March on Washington, at which Martin Luther King Jr. gave his famous "I Have a Dream" speech. For this reason, some consider him the true "father of the civil rights movement" in the United States.
        - In 1964 he was awarded the Presidential Medal of Freedom by President Lyndon Johnson.
    - **Lesson Review**: Today, we will use our Problem Statements to move on to the Ideate phase of Design Thinking. We will also finish our chassis by attaching our wheels to our trucks, and finish by attaching our completed trucks to our deck.

- **Guided Practice**
    - **Design Thinking:** We are now moving from the Empathize & Define stages to **Ideate:** creating ideas.
        - Think/Pair/Share: Turn to a partner and share your problem statement. What train car can you create to solve your problem? Jot down ideas in your Design Journal for your car's exterior and interior design. Use the P.S.ARTS kit to add details- what images and colors will you use? What will it carry?
            - Example:
                - **Problem Statement**: My community needs <u>more access to fresh foods in our neighborhood</u> because <u>we want and deserve a healthy lifestyle</u>.
                - **Solution**: My box car will be filled with fresh fruits and veggies that can be transported to every house in my neighborhood so my community can enjoy healthy meals.
        - Teacher can share examples of different types of trains and what they can carry for inspiration: materials for manufacturing, cars, lumber, freight, fuel, timber, food, passengers, circus animals
    - Make Axles, Attach Wheels to Trucks, Attach trucks to Deck. Use this video to walk students through the process: Lesson 5 Demo (1:57)
        - <u>Cut list for Axles</u>:
            - **AXLES**: wooden skewers, 4" in length
        - **Making the Axles**

        - Using the wooden skewers, create four (4) axles each 4” in length. Cut from the bottom of the skewer to avoid the pointed end.
    - **Attach Wheels to Trucks using Axles**
        - Fold truck pieces to create a box- the square with the hole should be on top. Temporarily secure the box with a small piece of tape, we will be unfolding the box eventually to attach to the deck.
        - Next, insert the two axles into the front and rear corrugation holes of the bottom of the truck. Equal parts of the axle should protrude from the trucks.
        - Place the wheels on the axles and secure them with a drop of hot glue on the ends of the axles. *Teacher tip: students should only need the hot glue gun for a short time, so a limited number of hot glue guns can be set up in different areas in the classroom.*
    - **Measuring Deck for truck placement**
        - Place Deck horizontally.
        - Measuring placement for trucks: Measure 1 inch from the right hand side of deck. Draw vertical line.
        - Next measure ½ inch from the bottom and top of the deck and mark. Line up truck to the lines to measure and trace the diameter of Truck for accurate measurement. Square should measure 3”x3”.
        - Once you have the outline of your truck, draw a diagonal line from opposite corners to create an X. Use your screwdriver to pierce a hole in the center of the X. Don’t forget to place a piece of cardboard underneath to protect the table!
        - Repeat all steps on the left side of the deck to create two spaces for trucks.
    - **Attach trucks to deck**
        - Unfold the truck so it is flat.
        - From the top side of the deck place the brass brads through the deck and through the untapped truck assembly hole in the top. Fold out the ends of the brad to secure it.
        - Once attached, close and secure the Truck overlapping tab with hot glue or tape.

- **Reflection** *(recap, deepen, check for understanding)*
    - A. Philip Randolph saw a need to fight for the rights and liberties of Black American workers, which led him to organize impactful events such as The March on Washington. How can you represent the solution to your problem statement in your train car design?

Differentiation:

- Students will approach the assignment potentially in different orders. As students start to play with cardboard, they don’t always follow the making process in the order that it is provided. They will most likely work based on which cardboard pieces they have on their

hands. “Do I cut out all of the wheels first, then make the axles? Or do I cut 2 wheels, cut an axle, then assemble them until I have 4 sets?” Students will be working at different paces so be prepared to accommodate them while helping others stay on track, or catch up if they are not as fast as others.

- Students will refer to provided videos that show two different maker’s perspectives and methods of accomplishing the same cuts.

Assessment:

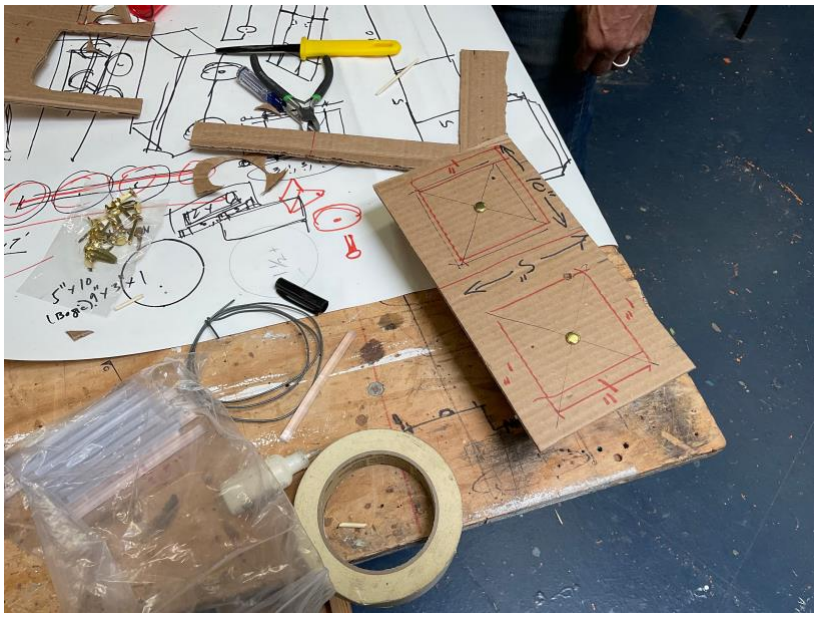
Students will successfully attach the wheels and axles to the trucks, then attach the trucks to the deck of the train car.

Teacher Takeaways:

- Think of other subjects or instances where we use problem solving. Why is having this skill important?

Classroom Resources:

- Info on Asa Philip Randolph: https://aflcio.org/about/history/labor-history-people/asa-philip-randolph



Content Standard(s)

CCSS.ELA-LITERACY.RI.4.3

Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

CCSS.ELA-LITERACY.SL.4.4

Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

CCSS.Math.Content.4.MD.A.3

Apply the area and perimeter formulas for rectangles in real world and mathematical problems. *For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor*.

NGSS

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VAPA Standards

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Social Justice Standards:

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JU.3-5.15: I know about the actions of people and groups who have worked throughout history to bring more justice and fairness to the world.

Social Emotional/CASEL connections:

SELF MANAGEMENT: setting personal and collective goals

SELF MANAGEMENT: using planning and organizational skills

RESPONSIBLE DECISION-MAKING: demonstrating curiosity and open-mindedness

Tinkering Tool Kit Lesson 6

Lesson Title: Attachment and Support Techniques

Grade Level: 4th

Lesson Length: 1hr

Lesson Objective(s): Students will learn attachment techniques including L Brace, Gussets, Flanges, and Sistering.

Essential Question:
How do images influence our views of the world?

Key Vocabulary:

- **Attachment Techniques,** *n.* - Methods of sticking material pieces to each other. Also known as “cardboard connections” as these techniques work especially well for when working with cardboard.
- **Design Thinking,** *n.* - A non-linear process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. Involving five phases—Empathize, Define, Ideate, Prototype and Test—it is most useful to tackle problems that are ill-defined or unknown.
- **Gusset,** *n.* - An attachment technique done by attaching a triangle inside a corner to make the angle strong. You can also combine this with an L brace.
- **L Brace**, *n.* - An attachment technique. A bent L of cardboard attached to both sides of a corner gives more surface contact.
- **Flange,** *n.* - An attachment technique done by cutting and bending flaps in your material to create more surface area. This is like a built-in L brace. It works well with tubes.
- **Sistering,** *n.* - An attachment technique done by attaching a separate piece to two adjacent parts to get more surface contact.
- **Slot construction,** *n.* - An attachment technique done by cutting slots into two pieces and sliding them to fit together. Also known as “interlocking slots” (refer to lesson 2).
- **Couplers,** *n.* - A thing that connects two things, especially mechanical components or systems.

Materials:

- Tinkering Toolkit: canary cutter, scissors, pencil, tape, glue, tape measure, and a straight edge
- Design Thinking student resource
- Design Journal or graphing paper.
- Cardboard
- Slide Deck (for teacher)

Safety Protection

- Gloves

- Safety Goggles

Anchor Artist/Engineer: Teddy “Stat” Phillips.

Instructional Sequence:

- **Introduction** *(safety practices, preview, check for prior knowledge, & set tone)*
    - **Anchor Artist:** Teddy “Stat” Philips, a Seattle-based engineer and artist instrumental in developing representative artwork for the Black Lives Matter movement.
        - Phillips saw a problem in his neighborhood, and across our country, and looked to design as a way to make a statement, launch a cause, and support a movement. He empathized with the community, worked to deeply understand the issues being faced, and developed artwork that represented the people and the problems being confronted. He painted the “I” in the Black Lives Matter mural located on East Pine St. in Seattle.
        - Prior to his artwork, Teddy worked as a Microsoft engineer and in 2017 developed a Black-centric trivia game app called “For the Culture”. He later followed up with “Para La Cultura” for the LatinX community.
        - When asked if he considers himself an engineer or an artist, Philips responded, “I don’t distinguish myself from the two. Art and engineering go hand in hand”.
    - **Lesson Review**
        - Understand and practice new attachment and support techniques using cardboard, as well as create our coupler and mount on chassis.
            - Just as Teddy “Stat” Phillips used art to communicate a message of justice, continue to brainstorm how your design will represent the solution to your Problem Statement. Keep in mind how the attachment techniques we learn today can be used as design elements in your train car.
            - **Design Thinking** - We’ll now begin the Prototype phase of Design Thinking. Experiment as you build. What works? What needs to change?

- **Guided Practice**
    - Mount coupler on chassis
        - Create and attach tabs front and back. This will be used in later lessons to attach the finished train cars together. Video demonstration of creating coupler: Train Car Coupler**.** (1:57)
    - Using scrap pieces of cardboard, students test out support *&* attachment techniques: L Brace, Gussets, Flanges, and Sistering. Reference slide deck for examples. Teacher guided:
        - L Brace: L Braces are used to attach two pieces of cardboard at a ninety-degree angle. Students might apply this in the train car to create seating, for example, or to make a divider between sections of the car. Using a

rectangular piece of cardboard, make a score along the flutes half-way through the rectangle on its short side. Bend the cardboard into a ninety-degree L shape. This L Brace can now be glued or taped to two separate pieces of cardboard to serve as the support bracket. Please note that the angle does not have to be set at ninety degrees, as the L Brace can support any angle desired.

- Gusset: Gussets serve a similar purpose to L Braces, with the ability to support two pieces of cardboard at a ninety-degree or other angle. The main difference is that a gusset is designed to maintain a set angle. Create a gusset using either a flat piece of cardboard cut into a flat triangular shape, or fold a larger piece of cardboard into that same triangle scoring along the flutes as necessary.
- Flange: A Flange is created by cutting out small flaps from the edge of a piece of cardboard. Flanges can be created from a flat piece of cardboard or from cylindrical shapes like a paper towel tube. Use the flange to attach the existing shape to another surface. For the train car, flanges might be used to create and attach cylindrical columns on the deck to serve as seating, support structures, or steam pipes.
- Sistering: Sistering is the concept of providing greater support to an existing surface. In the construction industry, sistering is applied to damaged wood by attaching a similar piece, such as a new 2" x 4" placed side by side with an existing, damaged 2" x 4". Sistering on the train car might be applied to create a reinforced wall.
- *Teacher tip: Model **Design Thinking**: "First I'm going to attach these sides together using this technique...that didn't work the way I wanted. What can I try next?".*

- **Clean up**

- **Reflection** *(recap, deepen, check for understanding)*
  - Think back to how Teddy Philips' art contributed to the Black Lives Matter movement. How can art influence others?
  - Why do you think Teddy Philips said that art and engineering "go hand in hand"?

Differentiation:

- Students can work in pairs when creating attachment techniques, using TTK booklet as a guide.

Assessment:

Teacher Takeaways:

Media Arts - we're surrounded by images, video, and other media that influence our view of the world. Identify one piece of media you interact with on a regular basis and analyze how it affects your point of view.

Classroom Resources:

- Slide deck with photo examples of different attachment and support techniques
- Train Car Coupler demonstration video
- See pg.11 of TTK Booklet for list of attachment techniques
- Teddy Philips:

https://crosscut.com/culture/2020/08/seattle-engineers-inner-artist-blooms-black-lives-matter
https://crosscut.com/2020/07/art-seen-seattle-artists-make-plywood-their-canvas
https://www.barrons.com/articles/worldwise-stat-the-artist-teddy-phillips-favorite-things-01600886561

Content Standard(s)

CCSS.ELA-LITERACY.RI.4.3
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Apply the area and perimeter formulas for rectangles in real world and mathematical problems. *For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor*.

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JU.3-5.15: I know about the actions of people and groups who have worked throughout history to bring more justice and fairness to the world.

Social Emotional/CASEL connections:

SELF MANAGEMENT: setting personal and collective goals
SELF MANAGEMENT: using planning and organizational skills
RESPONSIBLE DECISION-MAKING: demonstrating curiosity and open-mindedness

Tinkering Tool Kit Lesson 7

Lesson Title: Bringing it all together

Grade Level: 4th

Lesson Length: 1hr

Lesson Objective(s): Students will create the interior & exterior of their train cars using attachment techniques from Lesson 6 as well as the Visual Arts Elements of Design.

Essential Question(s):
- How do artists and designers care for and maintain materials, tools, and equipment? (VAPA)
- How does engaging in creating art enrich people's lives?

Key Vocabulary:
Prototype, *n.* - A product created to investigate the ideas.
Visual Imagery, *n.* - Group of images; images in general.
Elements of Design, *n.* - Line, Shape, Form, Space, and Color

Materials:
- Tinkering Toolkit
- P.S.ARTS kit
- Collection of materials to be upcycled, including materials included in their kit (wire, skewers, scrap fabric/mylar, wire, corks)

Safety Protection
- Gloves
- Safety Goggles

Anchor Artist/Scientist: Lonnie Johnson

Instructional Sequence:
- **Intro** *(safety practices, preview, check for prior knowledge, & set tone)*
    - **Anchor Artist:** Lonnie Johnson
        - In 1979, he left the Air Force to accept a position as Senior Systems Engineer at the NASA's Jet Propulsion Laboratory in Pasadena, California, where he worked on the Galileo mission to Jupiter.
        - In 1989, Johnson formed his own engineering firm and licensed his most famous invention, the Super Soaker® water gun, to Larami Corporation. Two years later, the Super Soaker®, generated over $200 million in retail sales, and became the number one selling toy in America.
        - Johnson holds a B.S. degree in Mechanical Engineering, an M.S. degree in Nuclear Engineering, and an honorary Ph.D. in Science from Tuskegee University.

        - "I feel like I have been blessed with a talent or a skill, and what motivates me, really, is to try to have a positive impact on the environment and people's quality of life,"

    - **Lesson Review**
        - Students create the interior & exterior of their train cars using attachment techniques from Lesson 6. Design should represent the solution to Problem Statement.
        - **Design Thinking** - In this lesson, you have the opportunity to Prototype & Test your ideas through your train car design. Use all the materials you have. Remember: the Design Thinking process is iterative, so you may be returning to previous steps while you build!

- **Guided Practice** *(model, explore, & engage)*
    - **Build interior & exterior of train car**
        - Start building the interior & exterior walls of your train car using attachment techniques, reusable materials, and P.S.ARTS kit.
            - Cut List for walls of Train car: 4x4 (2) & 4x12 (2)
            - Before attaching the walls and interior fixings to the chassis, students can use P.S.ARTS kit and reusable materials to add visual elements to their design. Take a moment to ask the whole group:
                - What **visual imagery** can you use in your design to convey your message? Consider using the **Elements of Art**: Line, Shape, Form, Space, and Color to communicate your message.
                - For example, if I want to portray a particular emotion with my box car, what colors would I use? What shapes or visual imagery can be added to explicitly communicate the function of the box car?
            - Students may choose the order in which to attach the walls and the interior fixings. For example, a student can start with attaching just two sides of the train car in order to keep the space more accessible to add the interior items. Experiment with different techniques to see how they hold up certain walls or furnishings. In the video example, you'll see how to use L Braces to attach the walls, but students are encouraged to experiment with different techniques: Lesson 7 Demo (6:09 - video can be shown in segments)
                - At 3:32 of the video, you'll see how Hanabee uses reusable materials to add to her train car.
        - *Teacher tip: As you float to each workspace, keep your eye out for students using the Design Thinking process. If time allows, take a moment to pause and share this example to the class. This can be reiterated in the Reflection portion of class as well.*
    - **Clean-up**

- **Reflection** *(recap, deepen, check for understanding)*
    - Gallery Walk - students walk around to each desk to observe each train car. What do you notice about someone's design? Name three choices that they made in their design. Which Elements of Art did you use to convey your message or purpose of your boxcar?
    - Lonnie Johnson's main motivation for his work is to have a "positive impact on the environment and people's quality of life". How does your train car represent a positive impact on your community?

Differentiation:

- Students may need to work with a partner to practice attachment techniques and connect their boxcars. Encourage students to use their TTK Tool Training Orientation Packet to remind them how to use tools and materials.

Assessment:

- Use Design Journal or class discussion to identify which aspect of their prototype can be improved.

Teacher Takeaways:

- Cross-curricular connection: The Design Thinking process is not limited to engineering or art projects. Explore how to use this process in other academic subjects, such as writing or other Project Based Learning activities.

Classroom Resources:

- Lonnie Johnson's website: http://lonniejohnson.com/
- Elements of Art: https://www.getty.edu/education/teachers/building_lessons/elements_art.pdf

Content Standard(s)

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Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

CCSS.ELA-LITERACY.SL.4.4

Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

CCSS.MATH.CONTENT.4.MD.A.1

Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36)*

NGSS

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Social Emotional/CASEL connections:

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SELF MANAGEMENT: using planning and organizational skills

RESPONSIBLE DECISION-MAKING: demonstrating curiosity and open-mindedness

Tinkering Tool Kit Lesson 8

Lesson Title: Bridging the Gap

Grade Level: 4th

Lesson Length: 1hr

Lesson Objective(s): Students will connect their individual boxcars into a class train.

Essential Question:
- How does collaboration expand the creative process? (VAPA)
- How do images influence our views of the world? (VAPA)

Key Vocabulary:
Prototype, *n.* - A product created to investigate the ideas.
Visual Imagery, *n.* - Group of images; images in general.
Elements of Design, *n.* - Line, Shape, Form, Space, and Color

Materials:
- Tinkering Toolkit
- P.S.ARTS kit
- Collection of materials to be upcycled, including materials included in their kit (wire, skewers, scrap fabric/mylar, wire, corks)

Safety Protection
- Gloves
- Safety Goggles

Anchor Artist/Scientist: Andrew Jackson Beard

Instructional Sequence:
- **Intro (15min)** *(safety practices, preview, check for prior knowledge, & set tone)*
    - **Anchor Artist:** Andrew Jackson Beard
        - Andrew Jackson Beard (1849-1921) was a prominent African American entrepreneur and inventor in the 1880s and 1890s. Born in Jefferson County, Alabama, Beard was largely self educated, and invented, among other things, a device for the automated coupling of railroad cars that has been credited with saving many lives.
        - As word of Beard's mechanical abilities spread, he began receiving competing offers for employment. He worked as a carpenter and a blacksmith before taking a job with the Alabama & Chattanooga Railroad.
        - Accidents were all too common, especially among workers who were charged with manually securing railroad cars to each other. The practice, known as coupling, involved slowly backing a railroad car connected to a locomotive toward another railroad car to add it to the train, and if

mistimed was extremely dangerous. To solve this problem, Beard invented the **Jenny coupler**, the first automatic coupler allowing brakemen to avoid having to risk limbs while manually coupling cars.

- **Lesson Review**
  - Today, we will be making our own version of Andrew Jackson Beard's Jenny coupler by connecting our boxcars together with brads. But first, let's plan our train landscape.
  - **Design Thinking**: As you finish building and connecting trains, continue to work through the different steps of Design Thinking.
  - Train landscape: The teacher has likely thought ahead on the best place to display the train in the classroom, however students can have a discussion on where to display the final train in the classroom.

- **Guided Practice (35min)** *(model, explore, & engage)*
  - **Let's connect!:**
    - With a partner, connect your individual train cars using brads.
      - Test the connection - can each train still move independently while staying secure?
      - Once students have figured out how to connect, they can find another group to connect their 4 train cars together, and so on. *Teacher Tip*: depending on the teacher's preference, they may leave it up to the students to find the next group to connect their boxcars, however this can be managed more directly by assigning groups to work with each other depending on where they are in their design process.
      - Eventually, the class train should slowly start to form.
    - Students who are still working on their design can continue to work and attach their trains in Lesson 9.
  - Clean-up

- **Reflection (10min)** *(recap, deepen, check for understanding)*
  - What messages do you see conveyed by your classmate's designs based on the visuals they included? You can reference the elements of design when describing their work: Line, Shape, Form, Space, and Color

Differentiation:

- Students who need more time to finish up their individual boxcars can continue working in a separate workstation and join their train cars in lesson 9.
- Extension: students who finish early can collaborate to brainstorm designs for caboose and locomotive.

Assessment:

- Use the Design Journal or class discussion to give specific examples of how the student used visual imagery to convey their message.

Teacher Takeaways:

- Cross-curricular connection: Social Studies - Explore the social, political, and economic implications of the development of the railroad for California. Who built our railroad, and why it is important to understand the significance of Andrew Jackson Beard's contributions in the context of California history at that time?

Classroom Resources:

- Andrew Jackson Beard: http://encyclopediaofalabama.org/article/h-3732

Content Standard(s)

CCSS.ELA-LITERACY.RI.4.3
Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
CCSS.ELA-LITERACY.SL.4.4
Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.
CCSS.Math.Content.4.MD.A.3
Apply the area and perimeter formulas for rectangles in real world and mathematical problems. *For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor*.

NGSS

3-5-ETS1-1: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

VAPA Standards

4.VA:Cr1.1: Brainstorm individual and collaborative approaches to a creative art or design problem.
4.VA:Cr2.2: When making works of art, utilize and care for materials, tools, and equipment in a manner that prevents danger to oneself and others.
4.VA:Re7.2: Analyze components in visual imagery that convey messages.

Social Justice Standards:

JU.3-5.14: I know that life is easier for some people and harder for others based on who they are and where they were born.
JU.3-5.15: I know about the actions of people and groups who have worked throughout history to bring more justice and fairness to the world.

Social Emotional/CASEL connections:

SELF MANAGEMENT: setting personal and collective goals
SELF MANAGEMENT: using planning and organizational skills
RESPONSIBLE DECISION-MAKING: demonstrating curiosity and open-mindedness

Tinkering Tool Kit Lesson 9

Lesson Title: Preparing to Present

Grade Level: 4th

Lesson Length: 1hr

Lesson Objective: Students will **r**eflect and describe their design process with peers to prepare for the final presentation.

Essential Question(s):
How can the viewer “read” a work of art as text?

Key Vocabulary:
Reflection, *n.* - Usually expressed in writing, to think back and reflect; give serious thought or consideration.
Collaborative: Joining with others in attentive participation in an activity of imagining, exploring, and/or making.
Design: Application of creativity to planning the optimal solution to a given problem and communication of that plan to others
Design Thinking: A non-linear, process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. Involving five phases—Empathize, Define, Ideate, Prototype and Test—it is most useful to tackle problems that are ill-defined or unknown.

Materials:
- Journals
- Pen/Pencil
- Complete or near-complete Train Car
- **Slide Deck**

Anchor Artist: Jake Montano

Instructional Sequence:
- **Introduction** *(safety practices, preview, check for prior knowledge, & set tone)*
    - Anchor Artist: Jake Montano
        - As a kid in Dallas with parents that worked endless hours, much of my time out of school was spent occupied with self-made projects. I had several hobbies—fawning over movies, making windy tunnels out of cardboard boxes, doodling, cooking things that often resulted in them becoming inedible—and dabbled in many, many other pursuits. His developing creativity was an escape from boredom and became the fuel for his work as an educator today.

        - Montano is a practicing ethnographer (the scientific description of the customs of individual peoples and cultures) but retrieved an education in the arts to satisfy his own soul as well. “So, despite calling myself a rabid and incurable tinkerer, it is people that I am most interested in.”
        - “I aim to contribute to enterprises that empower communities and uplift individual creativity and am an effective and awarded coordinator of teams large and small.”
        - He is currently the Senior Museum Educator at the Tinkering Studio at the Exploratorium in San Francisco.
    - Lesson Review:
        - Just as Jake Montano used the power of observation to influence his art, today we will observe our classmate’s art work and give constructive feedback. Students will share their Problem Statement, and describe their design process citing the **Design Thinking** process and VAPA vocabulary. This process will be in preparation for presenting your train car in Lesson 10.
        - Students who still need to finish can continue working and attach their train cars when finished.

- **Guided Practice**
    - **Writing activity (could be used as a Teacher Takeaway):**
        - Students will write a paragraph/fill out a worksheet on their experience building their train car. (Template/worksheet can be created)
            - Criteria - paragraph should include:
                - *Problem Statement*
                - How they used the **Design Thinking** process in creating their train car.
                - VAPA vocabulary
                - Tinkering skills & techniques used
                - Materials & tools used.
                - Anchor artist/scientists that inspired them
    - **Peer Review and Feedback**
        - Students are paired up (line up by birthdate, find a person with the same color clothing, etc.) then are asked to share and review each other’s train car. It’s ok if some train cars are still in process, they can share what they have so far. Decide who will be Student A and Student B.
            - Student A will share their Problem Statement, then describe how their train car represents their solution. (students can reference their worksheet to explain how they used **Design Thinking**.) Students can conclude by sharing an unsolved question/obstacle they may have regarding their concept/design. (3min)
            - Student B will use the T.A.G. system for providing feedback- use **Slide Deck** as guide for introducing the process. (2min)
                - **T**ell your partner something you like about the project
                - **A**sk your partner a question about the project

        - **G**ive a positive suggestion to your partner: this should be something simple that can be done for the remainder of class.
      - Students switch roles, repeating the process.
      - If time allows, students can rotate to another partner and repeat the process
    - Invite students to share insights they learned from their peer feedback with the whole group, and what changes they might make as a result.
  - **Finish up:** Give students time to finish up or rework any aspects of their train car based on the feedback.
  - Optional - Name the train

- **Reflection**
  - Jake Montano connected the arts with his passion for studying people's behavior and culture. How can the arts help us to get to know our neighbors and friends?
  - What aspect of your design are you the proudest of? What surprised you in the design process?

Differentiation:

- Provide templates for writing activity and feedback process. Templates for writing activity can include word banks of vocabulary. Peer feedback template can include sentence frames such as, "One thing I like about your project is..."
  "When I look at your train car, it makes me wonder…."
  "Your next step can be..."
- Extension: students can continue to collaboratively create locomotive and caboose.

Assessment:

- Worksheet describing the design process will assess the understanding of the Design Thinking, along with other integrated standards.

Teacher Takeaways:

- Writing activity can be used as an essay writing assignment for ELA.

Classroom Resources:
Slide Deck

https://www.exploratorium.edu/tinkering/about/staff/jake-montano

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Social Emotional/CASEL connections:

SELF MANAGEMENT: setting personal and collective goals

SELF MANAGEMENT: using planning and organizational skills

RESPONSIBLE DECISION-MAKING: demonstrating curiosity and open-mindedness

Tinkering Tool Kit Lesson 10

Lesson Title: Final Presentation

Grade Level: 4th

Lesson Length: 1hr

Lesson Objective(s): Students will share and demonstrate their learning of the Design Thinking process and Tinkering skills and techniques.

Essential Question(s):

- How does collaboration expand the creative process?

Key Vocabulary:
Collaborative, *adj.* - Joining with others in attentive participation in an activity of imagining, exploring, and/or making.
Design, *v.* - Application of creativity to planning the optimal solution to a given problem and communication of that plan to others
Design Thinking, *n.* - A non-linear process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. Involving five phases—Empathize, Define, Ideate, Prototype and Test—it is most useful to tackle problems that are ill-defined or unknown.

Materials:

- Final Model(s)
- Journals
- Pen/Pencil

Anchor Artist/Scientist: Review of all

Instructional Sequence:

- **Intro (15min)** *(safety practices, preview, check for prior knowledge, & set tone)*
    - Introduce non-judgmental critique
        - In using non-judgmental critique, we are using, “description, analysis, and interpretation. These are comments that say what we see, why it makes an impression, and what it might mean or how it makes the viewer feel.” (https://www.goshen.edu/). This avoids the use of "I like . . ." or, "I don't like . . . " in order to reach the highest value when talking about the work. Prompts include:
            - What do you notice?
            - What can you say about the use of: color/shapes/lines/texture/space?
            - What is something you’re curious about?
            - “When I look at your train car, I_____(wonder/feel/think/noticed)…”

    - Classroom Expectations when giving feedback:
        - Be kind
        - Give constructive criticism
            - What is working? If something is not working, how can they make it better?
        - Understand and appreciate differing styles
            - Even if it's "not your type"!
        - Keep an eye out for cool things that are happening!
            - Do you see someone using an attachment technique combined with other ones in a cool way? Awesome combination of textures and color? Talk about it!
        - Ask the classroom if there are any other expectations they can think of

- **Guided Practice (35min)**
    - Students will present their train car, citing the following:
        - Problem Statement
        - How their train car design represents the solution to their problem
        - How they used the **Design Thinking** process in creating their train car.
        - VAPA vocabulary
        - Tinkering skills & techniques used
        - Materials & tools used.
        - Anchor artist/scientists that inspired them
    - Audience gives responses through non-judgmental critique and questions.
    - If desired, critique templates can be given to students to write observations and feedback to give to their peers.
- **Reflection (10min)**
    - What did you learn when presenting your train car to the class? This can include how they feel about presenting, as well as responses form the audience.
    - What is something that made an impact for you during our Tinkering Unit and why?

Differentiation:

- Students may reference writing from Lesson 9 when presenting their train car.

Assessment:

Rubric may be used during final presentations to check for understanding of Design Thinking, VAPA, ELA, and Math standards.

Teacher Takeaways:

- Identify opportunities for peer feedback to be incorporated into other subject areas.

Classroom Resources:

https://www.goshen.edu/art/ed/critique1.html

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