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Appendix

STEM challenges are not recipes to follow, step-by-step instructions that guide students in creating identical projects, or processes that lead them to the same outcome. STEM is about allowing students to apply their content knowledge, creativity, critical thinking, and other skills as they work to solve a problem and create a solution.

STEM challenges will take time, so plan accordingly. Squeezing it in or treating STEM practices as "extra" may communicate that the skills and practices are not valuable. Our attitudes and beliefs are important as teachers; who we are informs who our students become. According to Hoffer, "If we model optimism, confidence, and courage about STEM in our classroom each day, students will absorb those" (2016, p. 3).

It is our hope that the STEM challenges included in this book will help you teach 21st century skills and STEM thinking, that these practices become a natural part of your classroom, and that STEM becomes a way of thinking and planning for you.

STEMulating
Design Challenges in Science

Grade 1

Challenge 1: Making Music: Recycling Is Instrumental!

Key Question

How can we create musical instruments using recyclable materials?

Problem

Your school is looking for new musical instruments for music class. Can you help think of ways to make instruments?

Design Challenge

With your team, use recyclable materials to create two musical instruments.

Teacher Notes

For this challenge, teams will use recyclable materials to create two musical instruments. First grade students should have a basic understanding of what recycling and reusing means, but it may be helpful to review these concepts.

First grade students should recognize properties of materials such as bigger or smaller, heavier or lighter, shape, and texture (TEKS K.5A) and know that materials can be reused and recycled (TEKS K.1B). In kindergarten, students may have used their senses to explore sound energy such as hitting a drum (force) to create a noise. Students may know that sound energy comes from vibrations that create sound waves. The sound waves travel through air or other mediums into our ears where they make our eardrums vibrate, and we hear sounds.

Students may have limited experiences with or knowledge of different types of musical instruments. Ask a music teacher, musician from your community, or faculty member with knowledge of instruments to speak to your class about different types of instruments.

To help each team select the instruments they want to create, you may list, share books about, post photos, or share videos of common musical instruments. You may also procure actual instruments on which students can play. Doing these things may help each team select the instruments they want to create. Student teams may decide to combine several ideas to create a new, unique instrument.

Vocabulary

physical properties

recycle/recyclable

sound

Materials

For student teams

- variety of recyclable materials
  - cardboard boxes, empty tissue boxes, egg cartons, and cardboard tubes
  - plastic containers and lids
  - cans
  - large and small plastic bottles with or without lids
- scissors
- items for creating musical instruments
  - rubber bands
  - string
  - cups
  - spoons
  - beans
  - plastic eggs
  - wax paper
  - construction paper
  - markers and crayons
  - craft supplies (balloons, chenille stems, craft sticks)
  - tape

Advance Preparation

Collect recyclable materials before you teach this challenge. There are recyclable materials collection posters included in the Appendix to help with your collecting efforts.

Use your Internet browser to search for videos using the terms "homemade instruments" and/or "children playing recycled instruments." Conduct this search prior to class to verify the content is appropriate for the class and the challenge.

Suggested Time Frame

- Ask, Imagine, and Plan: **45 minutes**; may be broken down over a few days
- Create, Test, and Improve: **45–60 minutes** for teams to build, test, and improve their instruments
- Evaluate: **3–5 minutes** for each team to present and demonstrate their instruments

The amount of time needed for this challenge may vary depending on your students' skills and research findings.

Texas Essential Knowledge and Skills (TEKS) for Science Connections

Science Concepts

1(5) Matter and energy. The student knows that objects have properties and patterns.

(A) The student is expected to classify objects by observable properties such as larger and smaller, heavier and lighter, shape, color, and texture; and

(C) The student is expected to classify objects by the materials from which they are made.

1(6) Force, motion, and energy. The student knows that force, motion, and energy are related and are a part of everyday life.

(A) The student is expected to identify and discuss how different forms of energy such as light, thermal, and sound are important to everyday life.

Science Process Skills

1(1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following home and school safety procedures and uses environmentally appropriate and responsible practices.

(B) The student is expected to identify and learn how to use natural resources and materials, including conservation and reuse or recycling of paper, plastic, and metals.

English Language Proficiency Standards (ELPS)

3(E) Cross-curricular second language acquisition/speaking. The student is expected to share information in cooperative learning interactions.

TEACHER GUIDE

ENGAGE

Introduce the problem by reading the problem and the key question to the class and showing images of or actual different musical instruments. In preparing for this challenge, you may choose to search the Internet for videos to show using such search terms as "children playing instruments made from trash". It is recommended that you evaluate these videos prior to class for appropriateness.

KEY QUESTION:

- How can we create musical instruments using recyclable materials?

ENGINEERING DESIGN PROCESS (EDP)

ASK

- Present the design challenge and identify the criteria and constraints.
- Create a "Know/Need to Know" T-chart and facilitate a class discussion to ensure all students understand the challenge.
- Facilitate the sorting of recyclable materials as a class including a discussion of the physical properties of each material.
- Divide the class into teams of 3–4 students and assign each team a place to work.

FACILITATION QUESTIONS:

- How can we create musical instruments?
- Which recyclable materials can be combined or used to make musical instruments?

SENTENCE STEMS:

- The problem is . . .
- The challenge is . . .
- To meet the criteria, the design needs to . . .
- The constraints are . . .
- To solve this problem, I need to know or learn more about . . .
- Others have tried . . .
- I would solve the problem by . . .

TEACHER GUIDE | ENGINEERING DESIGN PROCESS (EDP)

IMAGINE

- Guide the research process. You may provide research materials (access to the Internet or experts, artifacts, books, and magazines) to teams or lead all students through the research process.
- Provide books and magazines with pictures for reference.
- Define vocabulary and model techniques for research and note-taking as you facilitate the research process.
- Allow students to observe and explore available materials.
- Use the Facilitation Questions to help guide their exploration.

Note: Do not give materials to teams at this time.

SUGGESTED RESEARCH TOPICS:

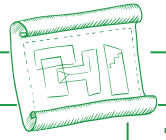
- how to make musical instruments
- recyclable or upcycled materials
- instruments made with recyclable materials

FACILITATION QUESTIONS:

- What recyclable materials can be combined or used to make musical instruments?
- What materials make the best musical instruments?
- What materials did not work as well as others at making musical instruments and sounds?
- Which combinations of materials did not turn out how you expected when using them to make music?

TEACHER GUIDE | ENGINEERING DESIGN PROCESS (EDP)

PLAN



Independent Planning

- Instruct students to create individual sketches of their ideas. Remind students to include details such as labels, measurements, and explanations of how each part of the system functions.
- Facilitate the use of the sentence stems below. Guide students in completing one of the sentences.
  - I think my team could solve this problem by . . .
  - My idea for solving this problem . . .
  - Based on my research and understanding, I think we should . . .

Team Planning

- Facilitate consensus building and planning, encourage engagement, and support detailed sketching.
- Provide two clean sheets of paper for each team to record its final plans.
- Provide feedback to student teams on their final designs and plans.
- Assist teams in managing roles and help team members understand their responsibilities within the challenge.
- Allow Materials Managers to collect the materials for their team.
- Observe teams to assess their collaboration, creativity, critical thinking, communication skills, and application of content knowledge.

SUGGESTED ROLES:

- Project Manager
- Construction Manager
- Materials Manager
- Creative Design Manager

FACILITATION QUESTIONS:

- Which recyclable materials will you use to create your instruments?
- What properties of each material make it useful in creating a musical instrument?
- What sounds will be created by your instruments?
- What will you name each instrument?
- How do you play each instrument? What part of your musical instruments will be manipulated to make sound?

SENTENCE STEMS:

- We will need the following materials . . .
- The steps we will take are . . .
- Our role assignments are . . .

TEACHER GUIDE | ENGINEERING DESIGN PROCESS (EDP)

CREATE/TEST/IMPROVE

- Allow teams to work together to create, test, and improve their instruments.
- Manage materials and ensure students follow safety guidelines.
- Remember not to take over the design process.
- Observe teams to assess and provide feedback on their collaboration, creativity, critical thinking, communication skills, and application of content knowledge.
- Encourage students to plan their presentations and how they will showcase their instruments using the following sentence stems.
  - The name of our instrument is . . .
  - We will showcase our instruments and designs plan by . . .
  - The steps/processes we followed were . . .
  - The materials we used were . . .

EVALUATE

- Facilitate the presentation process.
- Ask questions to help students think critically about the successes and failures of their designs.
- Take photos and/or video of each prototype to share with teams.
- Observe teams to assess and provide feedback on their collaboration, creativity, critical thinking, communication skills, and application of content knowledge.
- Assign each team or student one of the sentence stems to guide reflections on the testing of the musical instrument. You may choose to have students record their reflections in their notebooks or to share them orally with the class.
- Allow time for students to ask questions of each other, reflect, and note their observations.

PRESENTATION PROCESS:

1. The Project Manager (or designated team member) will explain why their team chose the materials they used.
2. A team member will play the team's instruments and demonstrate how they make music.
3. Allow the student audience to ask questions after each presentation.

FACILITATION QUESTIONS:

- What materials did your team use?
- Are there different materials available that might work better?
- How does your instrument meet the criteria?
- What can you learn from other teams' instrument designs?

SENTENCE STEMS:

- I observed . . .
- The part(s) that work(s) is/are . . .
- The part(s) that did not work is/are . . .
- The part(s) that could work better is/are . . .
- When we observed other presentations, we learned . . .
- We know we were successful because . . .
- We know our design met the criteria because . . .

Making Music: Recycling Is Instrumental!

Key Question

How can we create musical instruments using recyclable materials?

Problem

Your school is looking for new musical instruments for music class. Can you help think of ways to make instruments?

Design Challenge

With your team, use recyclable materials to create two musical instruments.

Criteria:

- ❑ Each instrument must have a name.
- ❑ Each instrument must make sound.
- ❑ Each presentation should include:
  - ❑ an explanation of how the team's instruments were created
  - ❑ a demonstration of how to play each instrument

Constraints:

- ❑ Teams will have 45 minutes to design, build, test, and improve their instruments.
- ❑ Teams must use at least two different recyclable materials in their instruments.
- ❑ Each team will have 3–5 minutes to present and demonstrate how their instruments can be used to make music.