Break a [cardboard] leg!: Collaborative design of an integrated arts & engineering activity (Resource Exchange)

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Abstract

We have traditionally designed hands-on activities to engage middle-school students in a summer camp where they work in teams and access a wide array of tools and materials. We created, tested, and improved a three-days integrated arts and engineering activity for two years based on the Gestalt's visual intelligence rules. We created a laser-cut cardboard box that the participants can transform into a portable shadow puppet theater that contains 2D pre-cut geometric shapes (2D-geons) to make the puppets. As part of the possible extension ideas, each child could assemble and code a LED circuit to produce lighting effects according to a story they invent. Observations during the implementation showed that shadow puppetry helps the students understand the connection between engineering design and the effect of artistic decisions on it.

Grade level

Middle-school students

Time

3 sessions, 2 hr/each

Materials per student

Scenario

Cardboard box (9x12x2.5 in)
A4 vellum translucent paper
Blue painters tape
Carbon paper (only if the user does not have a laser cutter)
Cardboard cutter (only if the user does not have a laser cutter)

Background

A4 green-colored transparency
A4 blue-colored transparency
A4 red-colored transparency
A4 uncolored transparency
Medium binder clips
Fine point permanent marker – Black

Puppets

Construction paper
6 mm metal brads paper fasteners
Wooden stir sticks (7x1/4 in)
Invisible tape
Foam
Sharp pin
Blunt tip scissors

Storytelling

A4 white paper
Pencil
Ruler

Lighting

Flash light

Learning objectives

General

Identify and blend concepts and skills from the neurosciences, engineering, theater production, new media arts, and geometry to produce a more integrated understanding of knowledge that promotes and protects human rights and fundamental freedoms.

Specific

1. **Recognize and use the visual perception, optics, and geometry principles that are useful in shadow puppetry.**
2. **Apply the engineering design process to solve problems related to shadow puppetry production**
3. **Create meaningful stories related to the promotion and protection of human rights and fundamental freedoms.**
4. **Select, analyze and interpret a shadow puppetry piece as a sample presentation.**

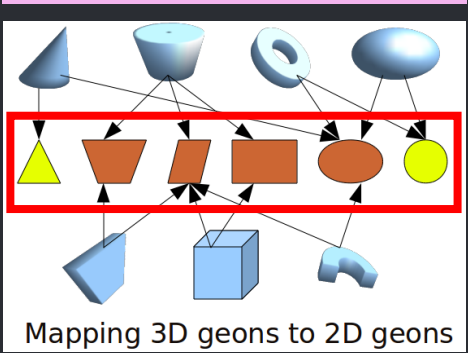
Shadow Puppetry Box - Set up

Option 1: Without a laser cutter

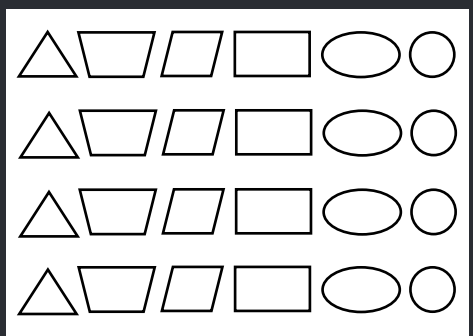
- Create a template similar to the figure below (A4 size). The shapes should be big enough to be manipulated.
- Copy the template with carbon paper on the top of the box.

Option 2: With a laser cutter

- Use a compatible software to design and print the frame and geometric figures on the top of the box
- Use the following parameters: Vector, 12 horizontal, 9 vertical



Mapping 3D geons to 2D geons



Connection with American educational standards

MS-ETS1 Engineering design.
MS-ETS1-1 and MS-ETS1-2

MS-PS4 Waves and their applications in technologies for information transfer.
MS-PS4-2

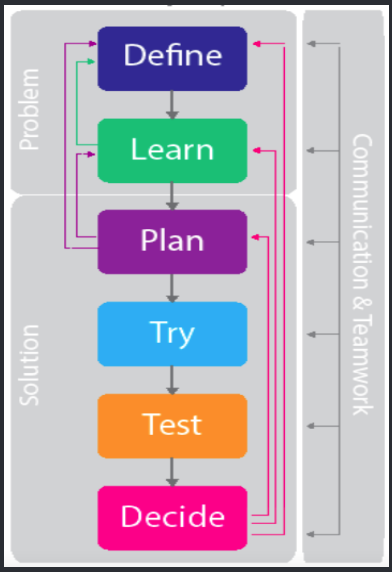
CCSS.MATH.CONTENT.7.G.B.6 Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.
7.G.B.6

TH. Theater – Responding.
TH:Re9.1.7b

VA. Visual arts – Creating.
VA:Cr1.2.7a and VA:Cr2.3.7a

VA. Visual arts – Production.
VA:Pr5.1.7a and VA:Re.7.2.7

Engineering design process



Moore, T. & Douglas, K. A. (2016)

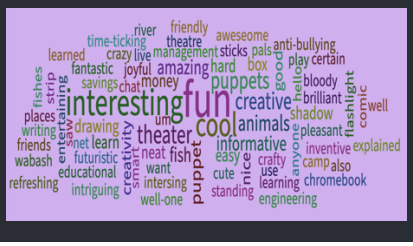
Remember...

1. This activity can be done individually or by teams (children, children-adults, adults).
2. Adults are encouraged to let the children lead the activity while they help facilitate the activity. To help ease this process, define who leads each part of the project.
3. Keep in mind that some activities require more time to be done according to the participants' level of detail and skills development.

Extension ideas

- Electronic LED connection to produce lightning effects according to a story they invent
- Stories based on a DEI problem proposed by the instructor

Impact



Contact information

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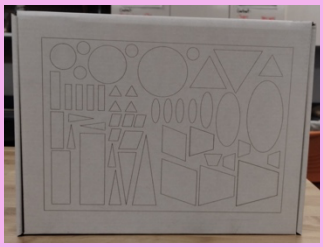
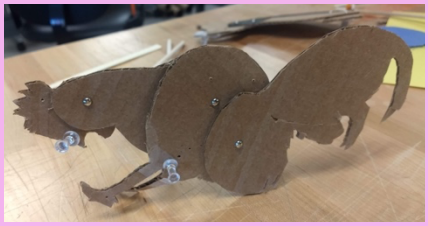
Activity development

Define – Session 1
The students will act as engineers who have to deliver a 5-min shadow puppetry show. They have to build their own theater, puppets, story, and light effects. Using the cardboard box, they can create the frame of the scenario with a laser cutter or a safe cutter for students. They can work in teams or individually, depending on the availability of the resources and the intention of the instructor.



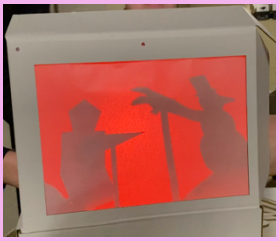


Learn – Session 1
Ask the students to build up the screen using the translucent vellum paper and tape to cover the frame. Following, they construct the puppets with the geometric figures previously designed on the box based on the basic geometric figures (2D geons). They can get inspired by the following video (https://www.youtube.com/watch?v=IU568Yc7gZA). Use construction paper to make more if needed. The puppets can have mobile joints, so the students have to hold them with fasteners and paste a wooden stirrer to each, according to the puppets' movements.

Plan – Session 2
Show the students the following video related to creating stories : https://www.youtube.com/watch?v=NpWHZJZQDSE. Next, ask them to create a story step by step, drawing, writing, or both, on a sheet of paper, divided into six boxes: Box 1 - Character or characters intro with their characteristics, the setting they see, and their location in time. Boxes 2 to 6 - Central moments of the story (Introduction, Rising Action, Climax, Falling Action, and Resolution).

Try – Session 2
The students can modify the previous puppets or create new ones according to the invented story. Next, they can create backgrounds by using colored transparencies with the marker, according to their preference of color and the sensations they want to provoke (https://www.avanmuijen.com/watercolor-emotion-wheel). Each background will be placed in front of the flash light and supported on the binder clips.

Test – Session 3
Ask the students to rehearse their story with all the created elements and effects. Next, they present their performance to the audience they prefer or intend. Ask them to collect data that will help you make decisions and changes in your prototype based on the questions *What did work in your performance? What will you change?*



Decide – Session 3
The students will make the changes they consider will improve their performance and the experience of their audience. Ask the students questions related to the change they made: *What did you change? Why?*

Communicate – Session 3
Ask the students to perform again their puppetry show to a new audience. Finally, ask them to describe the prototype they created, explaining why they think your idea is a good design, and the what they learned in the project