

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

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Cristian Vargas-Ordóñez is a Ph.D. candidate in Engineering Education at Purdue University. His research interests include arts and engineering integration for epistemic justice and multicultural engineering education. He has experience in teaching and designing curricula for various educational programs, including first-year engineering and underrepresented pre-college students. Vargas-Ordóñez also has engineering experience in fields such as environmental control and operations management. He has published several papers on topics such as academic identity construction and transdisciplinary STEAM education.

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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.

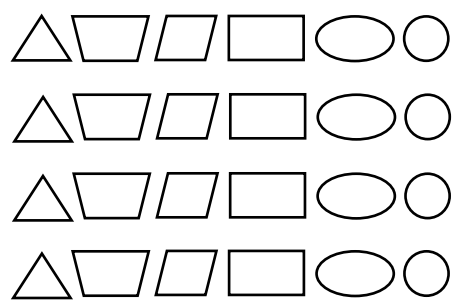
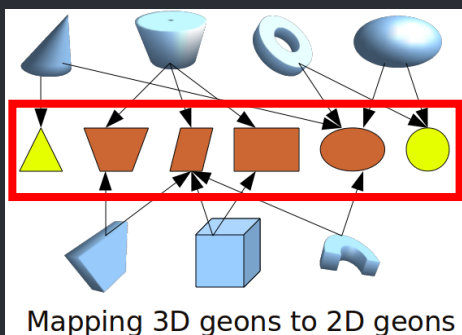
Shadow Puppetry Box - Set up

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



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

