Spaghetti Marshmallow Design Challenge

SUMMARY

In this design challenge, youth will get to know the work of architect **Allison Grace Williams**. Inspired by her work, they will utilize the engineering design process to build structures that address a need or desire in their community.

LESSON INFO

Grade: 6-8th grade.
Lesson Author: ExpandED Schools, New York Hall of Science, and STEM Educators Academy educator Suraia Fattah

MATERIALS

Hyperlinks:

These links are clickable!

- Lesson slidedeck*
- Vocabulary Words:
  - Engineering Design Process
  - Prototype
  - Evaluate
  - Brainstorm/Ideate

Materials per group of 4:

- 4 spaghetti marshmallow worksheets
- 2 photos of Allison Grace Williams's work (see images here and here)
- 2 Engineering Design Process (EDP) worksheets (optional)
- 1 measuring tape (optional)
- 20 uncooked spaghetti
- 3 feet of tape
- 1 marshmallow
- 1 pair of scissors
- 4 pieces of paper and pencils
- Post-it notes

To prepare enough materials for your class, you'll need multiple sets. For example, a class of 28, you will need 7 sets of the materials listed above (7 x 4 = 28).

PREPARATION

Before every lesson, be sure to:

- Purchase or gather the activity materials.
- Prepare materials and lay them out in the classroom.
- Project the lesson slide deck.
- If your room does not have a stable internet connection, download the powerpoint and videos beforehand.

Print:

- Spaghetti-marshmallow worksheet
- Photos of Allison Grace Williams' work here and here)
- Engineering design process worksheet

Cut:

- Photos of Allison Grace Williams's work and tape them up around the room for the gallery walk.
- Engineering Design Process graphic and tape it up in the room

LEARNING OBJECTIVES & STANDARDS

STEM Learning Goal: Content (What youth will KNOW)
MS-ETS1-4: The iterative process of testing the most promising solutions & modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.

STEM Learning Goal: Skill (What youth will DO)
Next Generation Science Standards: Constructing explanations and designing solutions

POSSIBLE ACTIVITY TIMELINE

Session 1

- Hook
- Introduce the content & the design challenge
- Build and test
- Reflect on the first round of building

Session 2

- Improve design
- Build and test again
- Reflect on the second round of building
- Closing

Bring learning to the community

- Ask youth to look up a nearby publicly owned vacant lot using this map. What do they think can be built here? What would it bring to the community?
- Identify a place in the community that was transformed into something valuable to the community (such as a vacant lot transformed into a community garden). Can you arrange a visit as a class to learn more about the transformation process?

Delivering the Lesson

HOOK

Allison Grace Williams is an accomplished architect who designed her work to be practical, economical and visually appealing. Her approach integrates the culture, climate, and urban context of the environment into her designs. **Start your lesson by exploring the culture, climate, and urban environment in your school's neighborhood:**

- Take a field trip through the neighborhood and have youth notice and choose something that they can change or add to make their communities thrive.
- Take a "field trip" in the school building and think of a space that can be transformed to benefit everyone. For example, could an empty playard be used differently or could the cafeteria be more inviting?

EDUCATOR CHOICE POINT:

The hook provided above is just one idea, and may not be the right fit for your youth. Can you think of a more relevant and engaging hook or plan one together with the youth in your program?

INTRODUCTION

1. Explain to the group that all over the world, people need homes, buildings to work in, and structures of all kinds. Architects are professionals who design buildings that need to take many elements into account, such as the building materials available, their budget, and the location where they're building. Explain that today, they'll be exploring the work of architect Allison Grace Williams.

2. Guide youth through a gallery walk of Allison Grace Williams' work, asking what they notice or imagine about the structures.

3. Explain that architects like Allison Grace Williams use the Engineering Design Process. Show the Engineering Design Process Worksheet, or use this graphic in the slidedeck and discuss each of the steps.

4. Then, connect Allison Grace Williams' work to the Engineering Design Process. Prompt youth to write an action word or phrase on a post-it note that Allison Grace Williams did while designing these buildings. For example: "talk to people about what they want the building to look like." Then, ask youth to match their action words to the corresponding step of the Engineering Design Process by sticking their post-it note on it . For example, "talk to people about what they want the building to look like" would get stuck to the "brainstorm" step.

QUESTIONS TO ASK DURING INTRODUCTION

What do you notice about Allison Grace Williams' work?

Why do you think she designed the buildings to look or function this way?

What structures or buildings have you seen being built in the community in the past year?

Do you think the building(s) being built in the community take the culture or urban environment into account?

DESIGN CHALLENGE

Architects, it is now your turn! A city developer wants to build on an empty lot in the area and they're asking the community to weigh-in on what should be there. Taking into account Allison's approach to architecture, create a blueprint and sample structure of what your team would like to see on this lot.

PLANNING

1. To anchor this building challenge in the engineering design process, all structures should meet these two requirements:

   a. The structure has to be free-stranding. No one should hold any parts during testing.
   b. The entire marshmallow must be incorporated within the design of the structure, not just placed at the bottom of the structure.

Have the whole group decide on fair rules for this design challenge together. Include youth in deciding what counts as "success" in this design challenge. Some suggestions are:

   a. You cannot alter the marshmallow. Eating it disqualifies your whole team. You may alter the shape and size of other materials (the spaghetti and tape).
   b. The structure must be at least ___ inches tall. *
   c. You don't have to use all of the materials, except for the marshmallow.
   d. You'll have ____ minutes to build.

**Adding a minimum height requirement adds a measurable component for youth to compare the success of their structures. We left the height blank for you to determine with youth.*

2. Hand out the Spaghetti Marshmallow Worksheet. Ask everyone to write the challenge in their own words in the first box. Use their responses to check that each person understands the prompt.

3. Give each group 5-10 minutes for planning; encourage teams to sketch their design ideas on the worksheet in the space for question 2. Pass out a few sample materials so youth are familiar with the properties and characteristics of each material.

QUESTIONS TO ASK DURING PLANNING

What type of design do you think will work best for the space you're thinking about? Why?

What inspired your team's design?

What buildings, already in the community or from Williams' work, are you using as inspiration?

BUILDING AND TESTING

4. Once each group has finalized their sketches, hand out the materials to each group and start the timer.

5. After everyone has completed their structures and time is up, have the groups reflect on whether or not they were able to build a free-standing structure similar to their sketches. If not, what were some challenges the group had in building the structure?

6. Explain that teams will now have a chance to use what they learned while testing to improve their current design to remain free-standing with the weight of the marshmallow or to add an extra feature to their structure Give teams time to sketch an improved design idea on their worksheet in question #4.

7. Once each group has finalized their sketches for the second time, hand out the materials and start the timer.

8. Once everyone has completed their structures and time is up, refer to the rules set for the design challenge. Did their designs fulfill the design criteria set out by the group?

QUESTIONS TO ASK DURING BUILDING:

Can you tell me about your design?

What kinds of things are you thinking about for your design? (strength, flexibility, strong shapes, etc.)

QUESTIONS TO ASK DURING TESTING:

What makes this structure strong enough to hold this marshmallow?

What are some of your observations?

What happened when you added the marshmallow?

CLOSING

1. Conduct a brief "gallery walk" to see each team's final structure.

2. Bring youth back together and ask reflection questions about their designs and the engineering design process. As youth share, be sure to ask them about the connections, if any, between their structure and any of Allison Grace Williams' designs.

QUESTIONS TO ASK DURING CLOSING:

What steps of the engineering design process did you use?

What were some challenges your group had in initially constructing your design?

What improvements would your team make to improve your design?

What connections do you see between your work and design and Allison Grace Williams' work and designs?

Educator Choice Points

You can adapt or maximize this lesson for the young people you work with. Use the guiding questions on this page to help you make choices to understand what youth know ("assessment"), to partner with youth ("youth role"), and to ensure all youth feel successful ("differentiation"). Each section includes a few ideas and space for you to choose a strategy that will work for your group.

ASSESSMENT

Educator choice point: How will you know that youth understand this content? Decide how you will check that youth understand the content from this lesson.

- Walk around the room to check that youth understand their task as they complete the Spaghetti Marshmallow worksheet.
- Take notice how youth are working together in teams. Is everyone participating? Are decisions being made with input from all or just a few? Are they able to complete the design challenge in time allotted?
- Listen as youth work together and share their ideas. Are they using the vocabulary when building and testing?
- During reflection, ask youth to connect the vocabulary with the Engineering Design Process. Are they able to do so?

To check that the youth understood the content from this lesson, I will _____.

YOUTH ROLE

Educator choice point: Where do youth have voice and choice in this lesson? Decide where and when youth can shape the activity.

- Picking their groups (4 youth/group).
- Creating the fair testing rules and constraints for the design challenge.
- Selecting an inspiration for their structure such as one of Allison Grace Williams' designs
- Deciding how long each timed section of the challenge should be.

Youth will have voice and choice when _____.

Educator choice point: How can you make opportunities for youth-to-youth interaction? Decide how youth will interact in this lesson.

- Small- and whole-group discussions
- Working as a group to decide on fair rules and constraints for the engineering design challenge.
- Sharing their designs with each other during the gallery walk.

Youth will be able to interact with each other when _____.

DIFFERENTIATION

Educator choice point: How will you support all youth to feel successful in this lesson? Decide how you will support youth working at different paces and with different needs.

- Keeping youth who finish early engaged by coming up with an idea about how they envision their structure to be used by the people of the community. Who will use it? When?
- Engaging participants who are disinterested in the activity by sitting with them to figure out what is going on. Consider allowing this participant to help by assisting the facilitator in handing worksheets out, removing gallery walk photos, etc. Aim to re-engage the youth in the design process if possible.

I can support youth working at different paces and with different needs by _____.

ADDITIONAL BACKGROUND INFORMATION

To learn more about the content in this lesson, educators and youth can...

- Learn about major architectural projects here in New York City, such as the Affirmation Tower
- Explore an article about the importance of the Engineering Design Process
- Listen to a podcast episode on the Engineering Design Process
- Explore photos of structures created by STEM Educators Academy educators in past trainings (or add your own photos) here.

As you seek out additional content, consider who is represented in the instructional materials. What voices are missing? Where might implicit biases be showing up in this content?