Professional Development Situation: Training

Skill Focus: Modeling Engineering Practices

Time Required: 80 minutes

IT'S A PROCESS

Participants will engage in NASA's Heavy Lifting balloon rocket activity to plan high-quality engineering activities.

Agenda

Welcome—5 minutes

See the Skill in Action—10 minutes

- Making Learning Fun video-based learning module

NASA Reading Jigsaw—15 minutes

- What Comes Next jigsaw reading about rockets

Hands-On Learning—30 minutes

- Heavy Lifting Activity from NASA

Conclusion—20 minutes

Materials

- Computer with internet connection
- Projector and speakers
- Flip chart paper and markers
- Pens for participants
- One copy of What Comes Next reading of NASA's Heavy Lifting and the NGSS Engineering Design Practices handout for each participant
- for each participant
- Materials for Heavy Lifting Activity from NASA
    - Large binder clip for test station (1)
    - Fishing line or smooth string

  Per Group:
    - Copy of NGSS Engineering Design Practices

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- Scissors
- 3 long balloons
- 1 bathroom size (3 oz) paper cup
- 2 straight drinking straws
- 50 small paper clips
- 1 Sandwich size plastic bag
- Length of masking tape
- Balloon hand pumps (optional)
- Wooden spring-type clothespins (optional)

Before the Session

- **Read this training guide** to become familiar with the content and allow time to personalize the activities to best suit your presentation style. Watch all videos and read informational materials.
    - *Italics indicate text that can be read aloud or emailed to participants.*
- Send reminder email about the training. Determine if any participants require accommodations (sight; hearing; etc.).
    - *The next professional development opportunity to enhance our STEM skills will be on DATE at TIME at LOCATION. Our focus for this session will be "Modeling Engineering Practices". Let me know if you require any accommodations to participate in the training. I am happy to answer any questions you have and look forward to seeing you at the workshop. I can be reached at CONTACT INFO.*
- Gather all materials needed for the training.
- Develop a list of possible questions participants might have during the training. Create potential responses to be explored through informal conversation. Review any key terms or ideas that may be unclear.
- On the day of the training, test the audio and video equipment.

Training Outline

Welcome (5 min)

- Greet participants as they arrive. Make sure everyone feels welcome and comfortable.
- Introduce yourself and the focus of the session: "Modeling Engineering Practices".
- Ensure participants are aware of the locations of restrooms facilities, refreshments, etc.
- Have participants make a name tent with their name on one side and a description of one of their favorite pieces of technology on the other side.

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- Have them share their name tents with their tables as a way of introducing themselves.

See the Skill in Action (10 min)

- Cue up the Making Learning Fun video-based learning module.
- Show the introductory video (step 1) to give participants a sense of the engineering task youth were asked to complete.
    - *Watch as the instructor uses local issues to help youth connect to the design task. What does she say to make this engineering task accessible to everyone?*
- Show the video of the instructor in step 3. Re-watch it if participants need a second viewing to hear the instructor's talk moves.
    - *How does the instructor talk about re-design and failure?*
    - *What are the parts of the design process that the instructor emphasizes? Would you emphasize the same ones?*
- Debrief.
    - *There is no, one, design process that guarantees a great outcome. Design is always a long process that isn't linear; it has a lot of twists and turns and it can be very frustrating, but it's important to be lighthearted and encourage youth that it's the process that counts.*

"What Comes Next" Jigsaw Reading (15 min)

- Pass out the "What Comes Next" chapter of the NASA Rockets Educator Guide and introduce the jigsaw reading strategy.
    - *We are going to use a strategy called a "jigsaw" to read this document. There are six pages, each with information that stands alone. You will each read a section and collaborate to summarize it into a 140-character "tweet" to share with the room. You want to be as pithy as possible: brief and substantive. You may use emojis (like happy faces, etc.).*
- Split participants into six groups of 2-3 each and assign each a page to read and "tweet" about.
    - Note: If your group is larger than 25, you can have two groups read and "tweet" about page 1, etc.
- Give them 10 minutes to work.
- Ask participants to share their "tweets" about the reading (and they can elaborate if 140 characters aren't enough).
    - *This reading was designed to give you some context, history, and information about some of the most admired engineering projects of our time: those at NASA.*

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In the next section, we are going to test out some designs of rockets in order to think about propulsion, load, and lift.

Hands-On Learning (40 min)

- *We are going to design a rocket that can lift heavy weight into space, and it is an activity that you can do with youth in your program.*

- **Trainer note:** The focus of this activity is not only to have participants build a successful rocket, but to be comfortable with testing and getting a result that they may think of as failure at first. The idea is to understand that every test creates some understanding that leads to a better design — in that sense it is a success! This is the value of trial and error. It is important to **identify a less-than-ideal outcome as an opportunity to learn**, and to use what is learned to improve the next attempt at success. Sometimes youth become frustrated with what they think of as failure, but if they identify their actions as a step towards success, the frustration is diminished.

Rocket-Building Procedure

- For this section, you will follow NASA'S Heavy Lifting guide, but don't share the guide with participants until they are finished. The following is copied from this guide for reference:
  - 1. Divide your students into teams of three. Explain the project to them.
    - "NASA is looking for creative ideas for launching heavy payloads into orbit. Payloads include parts and supplies for the International Space Station and spacecraft that will carry humans to the Moon and Mars. NASA is also interested in rockets that can transport large fuel tanks that will be used to power deep space rockets. You are challenged to build the most efficient heavy-lift rocket from the same set of materials. The team that is able to lift the greatest payload into space (the ceiling) is the winner."
  - 2. Provide each team with an identical kit of materials. Tell them that any or all of these materials can be used for their rockets.
  - 3. Review the launching procedure. Explain how the straw guides the rocket up the fishing line or string and that the line must be held snug to the floor for the launch. Remind the teams that they only get three balloons. They can launch as many times as they want to but should try to improve how many paper clips they can successfully lift.
  - 4. Draw a chart on the board for teams to record their results (i.e., the number of paper clips that reach the ceiling).

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Closure (20 min)

- Pass out the activity guide for NASA's Heavy Lifting and the NGSS Engineering Design Practices handout.
- Participants are now going to think about their design experience and relate it to the processes on the NGSS Engineering Design Practices page.
    - *Engineering is a complicated process that is not always linear. Look at the Engineering Design Practices page and think about what you and your partners did as you engaged in engineering the heavy lifting rockets.*
- Ask participants to cut apart the squares an create a "mind map" or conceptual drawing/representation of their process.
- Give participants 10 minutes to work.
- Ask participants to share their processes with others in the room. If time allows, you can do this with a "gallery walk" protocol in which one member of each group stays to explain their process to others, but the rest move to different groups to ask prompting questions.
    - *What were some things we tended to do often, as a whole room?*
    - *What are some unique elements of our designs?*
    - *I want to point out that these processes do not look alike. They don't have to follow a pattern. Many of us learned growing up that STEM follows one, prescribed scientific method, but actually, science and engineering are just sets of practices that work together. You can try this activity with your students in order to have them learn that there's no one "right way" to do engineering, but rather, that it's a process.*
- Thank participants for their attendance and encourage them to keep in touch with you and with others in the session.

After the Session

- Within 2-3 weeks of the training, email to all participants. Include the list of strategies used to support documentation of STEM as a resource of ideas for participants.
    - *Thank you for your participation in the recent Click2Science training on "Modeling Engineering Practices". I hope you found it useful. Consider meeting with a co-worker, supervisor, or friend to share what you learned. I look forward to continuing our learning at the next session on SKILL/FOCUS on DATE at TIME at LOCATION. Please let me know if you have any questions. I can be reached at CONTACT INFO.*

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- *Also, here is a link to NASA's Heavy Lifting activity.*

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NGSS Engineering Design Practices

Define a problem	Using what you know to think of a solution
Work with criteria and constraints	Develop a solution
Compare two ideas to choose the best one	Optimize the performance of our design
Test our design	Note failure points (where our design failed)
Collaborate effectively	Reflecting on how it went
Work through failure	Document the work

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