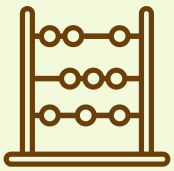




ECO-ENRICHMENT EXPEDITION

STEM^{2}D Topics:
SCIENCE & ENGINEERING

Target Population:
Students, ages 12-16

ECO-ENRICHMENT EXPEDITION is part of the Student Activities Series developed by FHI 360 for Johnson & Johnson's WiSTEM^{2}D initiative (**W**inning in **S**cience, **T**echnology, **E**ngineering, **M**athematics, **M**anufacturing, and **D**esign). The series features interactive and fun, hands-on activities for youth.

ECO-ENRICHMENT EXPEDITION

STEM²D Topic: Science & Engineering
Target Population: Students, ages 12-16

ACTIVITY DESCRIPTION

In this hands-on activity, students will have fun as they learn about the importance of composting and its positive impact on the environment. Using the information and materials provided, students will create a mini composting bin that will help them develop practical skills such as sorting organic waste, monitoring the decomposition process, and explaining the various uses of compost.

ESTIMATED TIME

This session typically takes 90 minutes to complete and should be conducted in one session.

STUDENT DISCOVERIES

Students will:

- Learn how STEM²D —Science, Technology, Engineering, Mathematics, Manufacturing, and Design—knowledge and skills are relevant to careers in environmental sustainability.
- Consider STEM²D concepts including composting, decomposition, and greenhouse gases.
- Participate in a team-based learning experience.
- Build important STEM²D skills, such as problem solving, observation, drawing conclusions, communication, and teamwork.
- Recognize that science and engineering can be used to solve a variety of complex challenges throughout the world.
- Realize that STEM²D offers diverse and exciting career opportunities.
- Have fun experiencing STEM²D!

STEM²D Skills

- Observation
- Problem Solving
- Communication
- Critical Thinking
- Drawing Conclusions
- Responsibility
- Accountability
- Time Management
- Teamwork
- Gardening and Agricultural

GETTING READY

Materials:

- Pre-Activity Checklist
- Tell My Story form
- PowerPoint: Eco-Enrichment Expedition
- Student Activity Handout: Eco-Enrichment Expedition
- Computer with projector, speakers, and Internet access

The following supplies are per team:

- Spray bottle containing water
- 1 Two-liter bottle (empty and clean)
- Organic materials
  - Bulking (Brown) Agents – wood shavings, small wood chips, newspaper strips, pieces of paper egg cartons
  - Food for the Microbes (Green) – lettuce, carrot peelings, apple core, bread crusts, banana peels, weeds, grass clippings
- Utility knife
- Plastic lid or paper plate (to catch excess water)
- Duct tape
- Marker
- Pushpin
- Latex gloves
- 1 Cup of potting soil *(optional)*
- 2 Empty paper grocery bags
- Chef's knife
- Cutting board

Estimated Cost:

Activity leaders can expect to incur less than $50.00 in materials costs when completing this activity with 30 students organized into teams of two students (15 teams). The cost could be significantly reduced by using recycled two-liter bottles.

ACTIVITY LEADER PREPARATION

- Read **Spark WiSTEM²D**. This is essential reading for all volunteers interested in working with youth. It defines the STEM²D principles and philosophy and provides research-based strategies and tips for engaging and interacting with students.

- Review the **Pre-Activity Checklist** (at the end of this document) for details and specific steps for planning, preparing, and implementing this activity.
- See the STEM²D Student Activities Overview for additional information about the Student Activity series.

STEP-BY-STEP INSTRUCTIONS

1. **Welcome & Introductions (5 minutes)**
   - Welcome the students.
   - Introduce yourself by saying your name, title, and your organization/company.
   - **(Today's Plan Slide)** Review the agenda. Explain that today students will learn about composting and related practices. Students will create a mini composter that allows them to observe the process of composting at home over several weeks.
   - Divide the large group into teams of two and instruct them to sit together for the remainder of the session.
2. **Career Awareness: STEM²D in the World of Work (15 minutes)**
   - **(What is STEM²D? Slide)** Explain that STEM²D refers to: Science, Technology, Engineering, Mathematics, Manufacturing, and Design.
     - Tell the students there is high growth among STEM²D careers and high demand in this area. Tell them your own career is only one of many in STEM²D fields.
     - Explain that some STEM²D careers do not require college degrees and still offer exciting, high-paying opportunities. Stress the importance of gaining mathematics skills to succeed in any STEM²D career.
   - **(My Story Slides)** Continue the introductions by talking about your educational and career path. Use the **Tell My Story** form as a basis for your remarks and be prepared to share your interest in STEM²D and how your work is connected to STEM²D. Be prepared to describe your job or a typical day and provide information about your background including:
     - When/why you developed an interest in your field.
     - The classes/courses you took in secondary school.

Engaging Students

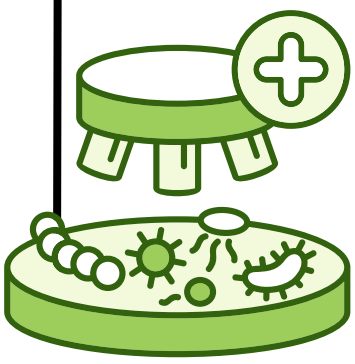
- Circulate and answer questions throughout the activity.
- Check frequently for understanding by asking open-ended, topic-specific, or process questions.
- Encourage students to ask questions to gain deeper understanding.

- Your post-secondary path, including any university and non-university institutions, certificates, or degrees. If you switched disciplines, make sure you explain why to the students.
- What your current position entails. Be sure to include how you use STEM^{2}D concepts and skills and what you do on a typical workday.

- **(Science and Engineering in the World of Work Slide)** Initiate an opening discussion and brainstorming activity around STEM^{2}D careers. Consider asking:
  - How would you define 'environmental sustainability'?
  - How might science and engineering be used in environmental sustainability fields?
  - What kinds of careers fit within the environmental sustainability pathway?
  - Give examples of Johnson & Johnson careers, job titles, and other careers that align with environmental sustainability.

3. **Content Presentation: Eco-Enrichment Expedition (30 minutes)**

- **(What is Compost? Slide)** Begin by asking what the students already know about compost. Explain what composting is and how composting can contribute to environmental sustainability.
  - Compost is organic material that has decomposed. Compost can be added to soil to help plants grow. Compost can be created in a controlled environment but also happens naturally.
    - In nature, composting happens as part of the decomposition process. Organic materials like leaves, dead plants, and animal matter break down over time through the action of microorganisms, insects, and other decomposers.
    - In a controlled environment, composting is an accelerated, aerobic (oxygen-using) biological decomposition process in which humans use specific kinds of microorganisms and other decomposers to turn organic materials like food waste into soil.



    - Anything that dies decomposes eventually; composting simply speeds up the process by providing an ideal environment for bacteria, fungi, and other decomposing organisms (such as worms, sowbugs, and nematodes) to do their work. The resulting decomposed matter, which often ends up looking like fertile garden soil, is called compost.
    - Compost is made by combining "green" items like food scraps and grass cuttings with "brown" items like leaves and wood chips, which break down over time.
    - Adding compost to a garden or creating optimal conditions for creating compost through vegetative blankets and reduced tilling enhances soil life.
- **(How Does Composting Happen in Nature? Slide)** Indicate that composting doesn't have to be intentional, and that composting is nature's way of recycling. The mechanics of intentional or planned composting are very similar to the natural decomposition of dead organics that happens everywhere, all the time. When plants, leaves, and other organic materials fall to the ground, they begin to break down and decompose.
    - Millions of tiny organisms, such as bacteria, fungi, and insects, play a crucial role in breaking down these materials. Different organisms work to break down organic molecules of different sizes and complexity. As these organisms feed on the organic matter, they release nutrients such as nitrogen and phosphorus back into the soil. These nutrients become available for new plant growth.
    - Composting is essentially nature's recycling process, but when we intentionally create ideal conditions—such as temperature, moisture, and aeration—we can accelerate decomposition. The end result is nutrient-rich compost that enriches soil and supports plant growth.
    - Composting has a positive impact on creating healthy ecosystems and sustaining life on our planet. Plus it gives us a way to recycle our food waste right at home!
- **(Composting Life Cycle Slide)** Review the life cycle of compost illustrated on this slide.
    - By composting, you are not just reducing food waste, but also creating a valuable product which helps to build healthy soils.

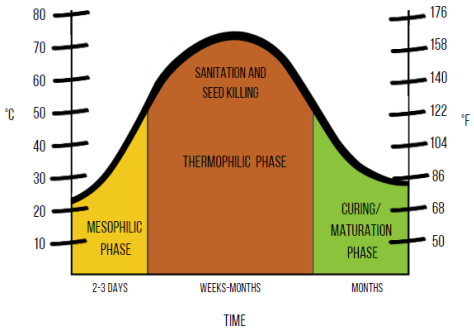
Key Words

- Aerobic
- Biodegradable
- Compost
- Compostable Materials
- Decomposition
- Greenhouse Gas
- Landfill
- Microorganism
- Organic Materials

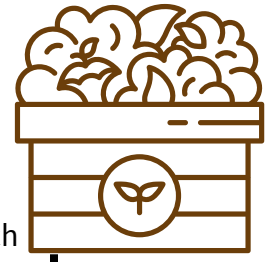
- When leftover food scraps, peelings, leaves and other organic material go through the composting process, they are broken down and eaten by billions of microscopic bacteria, fungi and other organisms. The resulting compost is a rich source of nutrients for plants.

- **(Compost Decomposition Phases Slide)** Explain that there is a decomposition process that organic matter goes through in order to create compost.
  - Rotting organic matter in a compost heap goes through three distinct aerobic phases of decomposition. Through these phases, simpler to more complicated and smaller to larger organic molecules are broken down. The three decomposition phases include:
    - Mesophilic: During this initial phase, decomposition speeds up, and heat is generated. It typically lasts a short amount of time.
    - Thermophilic: In this more active phase, high temperatures break down organic waste further. It usually lasts a couple of weeks.
    - Curing: The final stage involves cooling down and maturing. Composting materials reach their nutrient-rich state during this longer phase.
- **(Why is Composting Important? Slide)** Review the benefits of composting. Explain that composting is a powerful practice with far-reaching benefits for our planet. For example:
  - Compost reduces the amount of waste that goes to landfills or gets incinerated and re-uses valuable nutrients that would have otherwise gone to waste.
  - Composting saves taxpayers money, as less waste needs to be transported (sometimes 100s of miles) to waste processing facilities.
  - Carbon from the atmosphere is transferred into the soil through the release of organic compounds by plant roots or through the decay of plant material or soil organisms when they die.
  - Vegetables grown in soils with added compost are healthier, more productive, and more nutritious.
  - When done at a neighborhood level, composting can even help to bring people together and strengthen the community.

Decomposition Phases



- **(Traditional Composting Methods Slide)** There are many different composting methods. Each method has different advantages and disadvantages, and the best method depends on the materials, space, and climate.
    - Traditional composting methods include hot composting, cold composting, sheet composting, trench composting, and vermicomposting. *Note: Refer to the PowerPoint for descriptions of composting methods.*



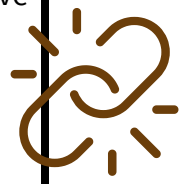
- **(Best Materials for Composting Slide)** Students should know that not all materials can be used in composting. There are specific guidelines that must be followed to ensure effective composting. The best compost is produced from a combination of green (source of nitrogen) and brown (source of carbon) waste.
    - Green matter materials include fruit and vegetable scraps, grass clippings, and coffee grounds.
    - Brown matter materials include wood ash, brown leaves, eggshells, shredded newspaper, wood chips, sawdust, toothpicks, and burnt matches.
- **(What to Keep Out of Compost Slide)** Explain that composting certain materials may lead to contamination, health risks, or unpleasant odors during decomposition. Composting certain materials can release harmful substances into the soil, affecting plants and nearby ecosystems.
    - Materials that should not be composted include meat and dairy products, oils or greasy foods, pet waste, human waste, diseased plants, plastic, synthetic fabrics, nutshells, and toxic plants.

- **(Who Uses Compost? Slide)** Discuss the different industries that make use of compost. Most teams will be able to identify the more obvious uses but they may be less familiar with compost usage in other fields.
    - Some fields include landscape and nursery, sod production, roadside projects, wetland creation, sports fields, erosion control, and stormwater management. *Note: Refer to the PowerPoint for more examples.*

4. Hands-on, Minds-on Learning Activity: Eco-Enrichment Expedition (30 minutes)

- **(Learning Activity Slide)** Introduce the challenge with these instructions:

    - Today, we are going to do a team-based activity in which you will create your own mini composter out of soda bottles.
    - Soda bottle composters are designed to be used as tools for composting research. They are small and inexpensive enough to enable teams to design and carry out individualized research projects, comparing variables such as reactor design, moisture content, and nutrient ratios of mixtures to be composted.
    - Consider playing the following 8-minute video that helps explain the individual steps of the activity: Creativity TV: Composting with a 2 Liter Bottle.
- **(Materials Slide)** Review the materials required to create a Soda Bottle Composter. Including soil as the base layer of the mini composter is not required but could help expedite the decomposition of organic materials by introducing microorganisms into the pile. *Note: Depending on the number of students, consider asking students to collect their own organic waste prior to the activity.*
- **(Instructions Slide)** Review the step-by-step instructions for building the Soda Bottle Composter.
    - Step 1: Using the utility knife, cut off the top of the bottle, approximately 1-2 inches below the neck of the bottle. *Note: Facilitators can perform this step ahead of the activity if preferred.*
    - Step 2: Turn the top upside down and tape one edge of the top to the edge of the soda bottle. Use the tape as a hinge so you can open and close the top easily. Taping the top of the bottle upside down creates a funnel for water to easily enter the body of the soda bottle.
    - Step 3: Use a pushpin to punch 8-10 small air and drainage holes along the sides and bottom of the bottle approximately 2-3 inches apart vertically and horizontally.
    - Step 4: Put on latex gloves and sort through the organic material. Separate your green material into one bag and your brown material into the other. Use the empty grocery bags to help organize the organic material.
    - Step 5: Once sorted, use the chef's knife and cutting board to cut the organic material into small 1-inch pieces. Ask students why they think the mini composter



Tips on Starting Connections

Encourage students to:

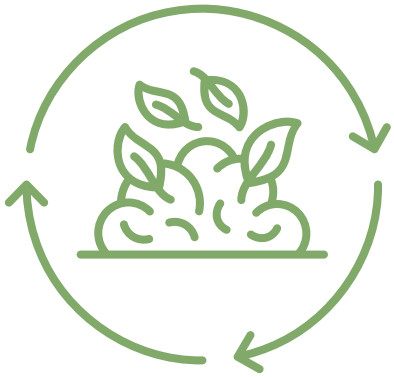
- Ask questions if they don't understand.
- Summarize what they have learned.
- Explain their thinking process aloud.
- Explain in their own words the process of decomposition.
- Compare and contrast the different types of compostable materials.

will work best if the organic material is cut into small pieces. Cutting the material into smaller pieces will help speed up decomposition.

- **(Fill Your Composter Slide)** Review the step-by-step instructions for how to fill your Soda Bottle Composter.
  - Step 6: If you choose to include soil, start your mini composter by adding a layer of soil to the bottom of the bottle. Soil contains microbes that can help jumpstart the microbial activity that breaks down compost. Keep in mind that this step is optional and not required for a successful compost but will help the process work more efficiently.
  - Step 7: Fill your soda bottle with organic layers by alternating between brown and green material. Remember that you want air to be able to diffuse through the pores in the compost, so make sure to keep your mix light and fluffy, do not pack it down.
  - Step 8: Once your soda bottle is full of organic material, use a fine spray bottle and dampen the materials in your soda bottle with water.
  - Step 9: Now your bottle is ready! Tape the top of the bottle closed to keep the moisture in.
  - Step 10: Place the bottle on top of the plastic lid or paper plate in case any of the moisture leaks out of the pushpin holes.
  - Step 11: Use a marker to draw a line on the side on the bottle at the top of your organic material so you can see how much the volume changes over time.
  - Step 12: Place your Soda Bottle Composter in a warm sunny place and observe. Explain to students that the sun increases the heat inside the mini composter, which will help microbes quickly break down the pile into useful soil fertilizer.
- **(Potential Issues Slide)** Discuss the potential problems and solutions that could arise throughout the composting process.
  - Strange compost smell: Turn the compost pile and add some additional brown organic material.
  - The compost is dry to the touch: Spray some water, add in greens, and mix the compost by gently shaking it.
  - Fruit flies are present: Add more brown material and stir the compost to allow more air into the pile.

Tips on Starting Conversations

- When you consider your future, what are you most excited about?
- Do you see yourself working with others, for a large company, with your friends, for yourself? Why or why not?
- Do you imagine yourself solving problems? Are you fixing or building things?
- What does the perfect workday look like to you?



- **(What Do You Think? Slide)** Engage the students in a discussion around what they think will happen inside the Soda Bottle Composter. Consider asking the following questions:
    - How long do you think it will take for the materials to start decomposing? Depending on the materials used, students could start to see changes as early as three weeks. Encourage students to look for changes in volume, color, temperature or moisture content.
    - Do you think the volume of the compost will increase or decrease with time? It's possible for the volume to shrink by 1/2-2/3 of the original size.
    - Which items do you think will decompose first? Students will know that decomposition has occurred when the original organic materials are no longer recognizable, and the compost has a dark, crumbly, soil-like texture. Leaves can take anywhere from a few weeks to a few years. Fruit and vegetable scraps like peels and cores can take between two weeks and a month to decompose. Small pieces of eggshells and toilet paper rolls can decompose within a few months.
    - Are there materials that won't decompose? Inorganic materials like glass, metal, stones, and plastics cannot decompose.
    - How do you think water plays a role in decomposition? When there is little or no water, decomposers may not be able to survive, which can slow down decomposition. Too much water slows down the composting process by limiting oxygen availability for microorganisms and can cause harmful bacteria growth. Proper moisture encourages the growth of microorganisms that break down organic matter.
- **(Student Activity Handout Slide)** Distribute the student activity handout to each team. Review the data that should be collected at home during this experiment. Encourage students to keep the handout next to their Soda Bottle Composter to record their observations. Students should share the responsibilities of monitoring and recording observations from their mini composter with their teammate over the next few months.

Tips for Working with Students

- Ask open-ended questions to encourage student reflection and discussion. For example:
    - Encourage the teams to think about why composting might benefit the environment.
    - Reinforce the need for young people to learn about environmental sustainability and what they can do to actively participate in sustainable practices.
    - Why might someone be interested in pursuing a career in the environmental sustainability?
    - What have you learned so far in this activity?
- Help students stay on track with time during the activity.
- Move around the learning space and provide support when necessary.
- Encourage all students to participate.
- Encourage students to take on leadership roles in their groups.
- Provide support and answer questions, as needed.

5. **Reflection (10 minutes)**
   - **(STEM²D Careers in Composting Slide)** Review the list of STEM²D careers that are connected to composting. Encourage students to research some of the careers listed to determine if one of the careers might be a match based on their interests.
   - **(Reflection Slide)** Ask students to reflect on the activity. Have students spend a few minutes thinking about the listed questions and then ask for volunteers to share their thoughts on any of the following:
     - How do you think this activity relates to a career in science and/or working at Johnson & Johnson?
     - Can you see yourself as a STEM²D professional? In what role? Why or why not?
     - What do you need to do to make this happen?
     - What is one thing you learned that you did not know coming in today?
   - **(Eco-Enrichment Expedition Slide)** Thank students for joining you today and encourage them to continue exploring careers in STEM²D.

EXTENDED LEARNING

Here are a few ways to extend the learning:

- Allow teams to alter different variables of the mini composter. Possible variations could include: order of layers, thickness of layers, amount of water, number of holes, location of holes, or lid on vs. off.
- Experiment with using the compost to grow seeds. This could be compared to using regular potting soil or topsoil for growing seeds. Set up a data table to collect measurements and compare growth to determine which soil is best for plant growth.
- Compare the differences in compost from various vegetable scraps or bulking materials.
- Compare the rate of decomposition to the size of the food scraps that are added to the composter.
- Monitor the temperature of the compost. Students can use temperature information to make adjustments to the compost, such as adding more carbon (brown organic material) if it's too hot, or more nitrogen (green organic material) or water if it's too cold.

Tips About STEM2D Careers

Share with students that there are many different kinds of careers related to STEM²D. Possible STEM²D careers related to this activity:

- Ecologist
- Environmental Engineer
- Industrial Engineer
- Environmental Scientist
- Agricultural Specialist
- Environmental Educator
- Biochemist
- Sustainability Chemist
- Climate Change Specialist
- Waste Management Specialist
- Sustainability Managers
- Organics Recycling Specialists
- Urban Planner

KEY WORDS

- **Aerobic**: Happening in the presence of oxygen.
- **Biodegradable**: Anything that can be broken down by living things such as bacteria and fungi.
- **Compost**: The product made from the natural decomposition process of anything that was once alive. Compost is often referred to as the recycling of organic waste.
- **Compostable Materials**: Materials that we know break down completely into non-toxic components and will not harm us or the environment.
- **Decomposition**: A natural process in which organic materials rot to the point where other plants can use their nutrients.
- **Greenhouse Gas (GHG)**: A gas in Earth's atmosphere that traps heat and contributes to global warming. Common GHGs are methane and carbon dioxide.
- **Landfill**: A place where garbage is buried and covered with soil.
- **Microorganism**: A microscopic or submicroscopic organism that consists of only a single cell and may include a bacterium, virus, or fungus.
- **Organic Materials**: Materials derived from living organisms, such as food, garden and lawn clippings, and wood waste, which can be recycled and turned into valuable products such as compost.

RESOURCES AND REFERENCES

Special thanks to Joy McBroom, Jerry Miles and Christopher Woeller at Johnson & Johnson for their insights and help developing this activity.

The following resources provide additional information or activities.

- Martin, D. L., & Gershuny, G. (1992). The Rodale book of composting. http://ci.nii.ac.jp/ncid/BA66298075.
- Teach Engineering, Cleaning up with Decomposers. Cleaning Up with Decomposers - Lesson - TeachEngineering

- Planet Natural, Composting for Kids. https://www.planetnatural.com/micro-composting/
- Cornell Composting, Building a Soda Bottle Bioreactor. https://www.compost.css.cornell.edu/soda.html
- Environmental Protection Agency, The Quest for Less. https://www.epa.gov/students/quest-less-activities-and-%20resources-teaching-k-8

ECO-ENRICHMENT EXPEDITION

Student Handout

RECORD YOUR OBSERVATIONS

Complete the table below based on what you observe inside your Soda Bottle Composter.

- **Compost Color:** The color of your compost will change with time. Record how the colors fade or get brighter with time.
- **Volume:** Use a marker to draw a line at the top of the compost pile each week. Note whether the compost pile volume is increasing or decreasing with time.
- **Material Not Present:** Identify the week you can no longer see specific organic material inside the Soda Bottle Composter.
- **Notes:** Use this column for additional notes (e.g., odor, moisture level, temperature, etc.)

Week #	Compost Color	Volume	Material Not Present	Notes
Week 1				
Week 2				
Week 3				
Week 4				
Week 5				
Week 6				
Week 7				
Week 8				
Week 9				
Week 10				
Week 11				
Week 12				

Were you surprised by any of your observations? If so, which one(s) and why?

_____

_____

Compare and contrast your mini-composter bottle against your peers. What is the same? What is different? Why do you think there is variation?

_____

_____

TELL MY STORY FORM

This form will help activity leaders and other volunteers prepare to talk about their STEM²D interests, education, and career path.

ABOUT YOU

Name: _____

Job Title: _____

Company: _____

When/Why did you become interested in STEM²D? _____

_____

_____

What do you hope young people will get out of this activity?

_____

_____

FUN FACT

Share a little about your background. Ideas:

- Share a memory from childhood when you first had your "spark" or "interest" in STEM²D.
- Detail your journey, highlighting what you have tried, what you learned, steps to success, etc.
- Failures or set backs are also great to talk about—difficulties, and/or challenges, and how you overcame them.

EDUCATION AND CAREER PATH

What classes/courses did you take in secondary school and in college that helped or interested you most? _____

_____

How did you know you wanted to pursue a STEM²D career? _____

_____

What was your post-high school pathway? What technical or educational institutions did you attend? If you switched disciplines, make sure you explain why. _____

_____

_____

What does your current position entail? Be sure to include how you use STEM²D during a typical work day. _____

_____

_____

PRE-ACTIVITY CHECKLIST

Eco-Enrichment Expedition

*The following checklist helps activity leaders plan and prepare to conduct the **Eco-Enrichment Expedition** activity with students.*

DID YOU . . .

- ☐ Read Spark WiSTEM^{2}D? This is essential reading for all volunteers interested in working with youth. It defines the STEM^{2}D principles and philosophy and provides research-based strategies and tips for engaging and interacting with students.
- ☐ Visit the event venue (optional) and/or finalize logistics with the organizer? Ask:
  - ☐ What is the date, time, and location of the event?
  - ☐ How will the room be arranged? Do I have access to tables? How big are they?
  - ☐ How many students do you expect? How will the students be organized/participate in the event? Knowing this will help you determine the quantity of materials to purchase.
- ☐ Recruit additional volunteers, if needed?
- ☐ Prepare for the activity? Did you:
  - ☐ Read the entire activity text prior to implementation?
  - ☐ Customize the activity, if desired, to reflect your background and experiences, as well as the cultural norms and language of the students in your community?
  - ☐ Complete the **Tell My Story Form**, which will prepare you to talk about your educational and career path with the students? *(optional)*
- ☐ Obtain the required materials? See the Materials and Estimated Materials Costs sections.
- ☐ Set up the site appropriately for the activity?
- ☐ Practice your presentation? *Make sure you can explain the concepts to students, if needed, and that you know the correct answers.*
- ☐ Bring a camera, if desired, to take photographs?
- ☐ Obtain and collect permission slips and photo release forms for conducting the activity, if applicable?
- ☐ Have fun!