BACKPACK DESIGN CHALLENGE

STEM²D Topics:
Design

Target Population:
Students, ages 12–16

Backpack Design Challenge is part of the Student Activities Series developed by FHI 360 for Johnson & Johnson's WiSTEM²D initiative (**W**inning in **S**cience, **T**echnology, **E**ngineering, **M**ath, **M**anufacturing, and **D**esign). The series features interactive and fun, hands-on activities for youth.

BACKPACK DESIGN CHALLENGE

STEM²D Topics: Design
Target Population: Students, ages 12–16

ACTIVITY DESCRIPTION

In this team-based, hands-on activity, participants will design a new backpack to be used by students.

ESTIMATED TIME

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

STUDENT DISCOVERIES

Students will:

- Participate in a team-based learning experience.
- Build important STEM²D—Science, Technology, Engineering, Math, Manufacturing, and Design—skills, such as creative thinking, critical thinking, problem solving, decision making, and teamwork.
- Realize that STEM²D offers diverse and exciting career opportunities.
- Have fun experiencing STEM²D.

GETTING READY

Materials:

- Pre-Activity Checklist
- Tell My Story Form
- Computer with projector, speakers, and Internet access
- PowerPoint: Backpack Design Challenge
- Video: Designing Backpacks (The Futures Channel) https://youtu.be/OlUji_v5rkg
- Student Handout: Backpack Design Challenge, *1 per student*
- Plain paper, 4 pages per team

STEM²D Skills

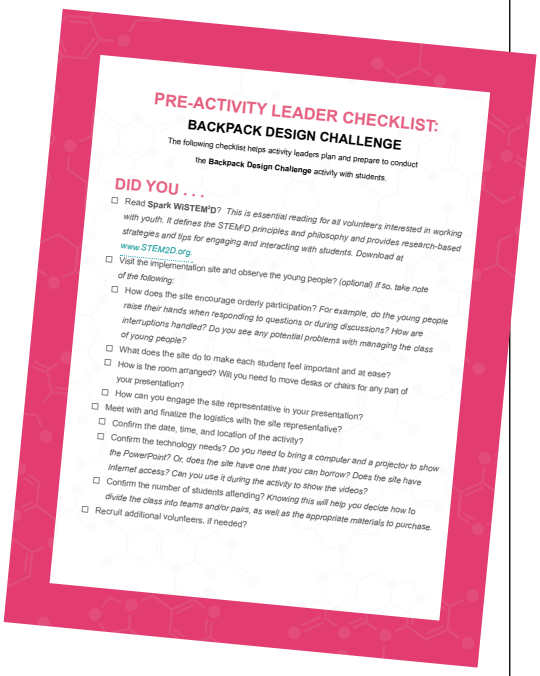
- Collaboration
- Communication
- Creativity
- Critical Thinking
- Decision Making
- Research
- Teamwork

- Poster board (22” x 28” or 56cm x 71cm)
- Markers/crayons, *1 package of markers or crayons containing multiple colors per team*
- Pen/pencil, *1 per student*

Estimated Cost:

Activity leaders can expect to incur less than $10.00 in materials costs when completing this activity with 20 students organized into teams of three to four students.

Activity Leader Preparation



PRE-ACTIVITY LEADER CHECKLIST:

BACKPACK DESIGN CHALLENGE

The following checklist helps activity leaders plan and prepare to conduct the **Backpack Design Challenge** activity with students.

DID YOU . . .

- ☐ 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. Download at www.STEM2D.org.*
- ☐ Visit the implementation site and observe the young people? *(optional) If so, take note of the following:*
  - ☐ How does the site encourage orderly participation? *For example, do the young people raise their hands when responding to questions or during discussions? How are interruptions handled? Do you see any potential problems with managing the class of young people?*
  - ☐ What does the site do to make each student feel important and at ease?
  - ☐ How is the room arranged? Will you need to move desks or chairs for any part of your presentation?
  - ☐ How can you engage the site representative in your presentation?
- ☐ Meet with and finalize the logistics with the site representative?
  - ☐ Confirm the date, time, and location of the activity?
  - ☐ Confirm the technology needs? *Do you need to bring a computer and a projector to show the PowerPoint? Or, does the site have one that you can borrow? Does the site have Internet access? Can you use it during the activity to show the videos?*
  - ☐ Confirm the number of students attending? *Knowing this will help you decide how to divide the class into teams and/or pairs, as well as the appropriate materials to purchase.*
- ☐ Recruit additional volunteers, if needed?

1. 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. Download at www.STEM2D.org.
2. Review the **Pre-Activity Leader Checklist** (at the end of this document) for details and specific steps for planning, preparing, and implementing this activity.
3. See the **STEM²D Student Activities Overview** for additional information.

STEP-BY-STEP INSTRUCTIONS: BACKPACK DESIGN CHALLENGE

1. **Welcome and Introductions (5 minutes)**
   - Welcome the students.
   - Introduce yourself by saying your name, title, and your organization/company and your favorite area/s of STEM²D.
   - Share that students will be learning about STEM²D careers and will be applying STEM²D skills during the session.
   - **(What is STEM²D? Slide)** Explain that STEM²D refers to: Science, Technology, Engineering, Math, Manufacturing, and Design.
   - Ask students and other volunteers to introduce themselves and state their favorite areas of STEM²D.
   - **(Today’s Plan Slide)** Review the agenda. Explain that today participants will design a backpack to be used by other students.

2. **Career Awareness: Design in the World of Work (10 minutes)**
   - **(STEM²D in the World of Work Slide)** Initiate an opening discussion and brainstorming activity. Consider asking:
     - How do you think design is used every day in the workplace?
     - What kinds of careers do you think people with an interest, aptitude for, or degree in design and/or design thinking would have?
   - **(Tell My Story Slide)** Talk about your educational and career path. Use the Tell My Story form as the basis for your remarks. Be prepared to describe your job or a typical day, and provide information about your background including:
     - When/why you developed an interest in design.
     - The classes/courses you took in secondary school.
     - Your postsecondary path, including the institution you attended and your degree. *If you switched disciplines, make sure you explain why to the students.*
     - What your current position entails. *Be sure to include how you use design and what you do on a typical work day.*
   - Weave in facts about design and STEM²D careers:
     - Tell the students that your career is only one of the many careers available in STEM²D disciplines.
     - Explain that STEM²D careers are high-demand, high-growth careers and are predicted to remain in demand over the next ten years.
     - Share a few Johnson & Johnson job titles and careers that may align with this activity..

3. **Content Presentation (10 minutes)**
   - **(What Do You Know About Design? Slide)** Ask students to raise their hands and share what they know about design. Choose three to four students to share an answer. Provide feedback on their answers.
   - Explain to the students that they will first learn about design and the design process; then, they will work as a team to design a backpack that will improve the utility, comfort, and aesthetic of backpacks currently on the market.

TIPS ABOUT STEM²D CAREERS

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

- Architect
- Civil Engineer
- Design Engineer
- Industrial Designer
- Mechanical Engineer
- Product Designer

KEY WORDS

- Aesthetic
- Consumer
- Design
- Design Thinking
- Model
- Utility

- Define:
  - **Utility:** the quality or state of being useful.
  - **Aesthetic:** a pleasing appearance or effect.
- **(Design Is Slide)** State: **Design** is creating, constructing, or inventing an object, plan, product, or system; it is also a human-centered mindset and collaborative approach that results in better experiences by uncovering unmet needs and championing meaningful relationships through user-friendly products, environments, and systems.
- **(What is Design Thinking? Slide)** Explain: **Design Thinking** is an approach or process focused on solutions to user concerns or problems. Design Thinking:
  - Is a process where we seek to understand the user
  - Is a collection of hands-on methods
  - Involves ongoing-experimentation
- Tell students that they will use design thinking in today's challenge.
- **(7-Step Design Process Slide)** Explain: The design process can have many steps. Today we will learn about a 7-step design process.
  1. *Define the Need:* Determine what problem you're trying to solve.
  2. *Brainstorm:* Think of different ways to tackle the challenge. Record the ideas.
  3. *Design:* Determine which brainstormed ideas are really possible. Explore ideas in further detail. Create working drawings so the idea can be built.
  4. *Build:* Make a **model** (a sample or miniature representation of the design) using the materials provided.
  5. *Test and Evaluate:* Test the model in a controlled and working environment. Gather data on the performance. Check the results to determine if the model solved the problem. Identify areas of concern and shortcomings and determine any changes to be made.
  6. *Rebuild:* Make any necessary changes to the design based on testing and evaluation.

7. *Share the solution:* Answer the following questions:
    - What is the best feature of your design?
    - What were the different steps you took to get your project to work?
    - Did you have to do something a few times to get it to work?

- **(Questions? Slide)** Ask the students if they have any questions about the design process before moving on to the challenge. Answer questions posed by the students.

4. **Learning Activity: Backpack Design Challenge (55 minutes)**
    - **(Backpack Design Challenge Slide)** Break the large group into teams of three to four students. Distribute the student handout and the challenge materials.
    - Explain that the students will be working in teams to design a new backpack in order to improve the utility, comfort, and aesthetic of backpacks currently on the market. They will follow the first three steps of the design process. Once they have completed their design, each team will present it to the group.
    - **(Backpack Design Video Slide)** Click on the link in the PowerPoint to show students a five-minute video on designing a backpack.
    - **(Backpack Design Challenge Define the Need Slide)** Remind students that the first step in the design process is to define the need. Indicate that one to define the need is to conduct research and ask questions of potential consumers. Define **consumer:** a person who purchases goods and services for personal use. Give an example of a question: “What would you like to carry in your backpack?”
    - Ask: What are other questions you could ask potential consumers? Call on two to three students to give suggestions.
    - Indicate that teams should come up with four questions to ask potential consumers; students in the class who are not on your team are your potential consumers. Stress that teams should get four to five answers to each question. Instruct teams to write down the questions to ask, as well as the responses, on the paper provided; then, review the responses and define the problem.

TIPS FOR MAKING CONNECTIONS

Encourage students to:

- Ask questions if they don’t understand
- Summarize what they have learned
- Explain their thinking process aloud

TIPS FOR WORKING WITH STUDENTS

- Ask open-ended questions to encourage student reflection and discussion. For example:
  - What are some of the strengths of your design?
  - What are you finding difficult about designing the new backpack?
  - What materials do you think you might want to use in the design?
- Help students stay on track with time during the group challenge.
- Encourage all students to participate in the challenge.
- Move around the learning space and provide support when necessary.

- **(Backpack Design Challenge Brainstorm Slide)** Say: Work as a team to brainstorm or generate different ways to design a backpack that would solve the problem. Tell teams to sketch, draw or write down potential ideas on the paper provided.
- **(Backpack Design Challenge Design Slide)** Explain: Once teams have recorded a number of different ideas it is time to move on to the design stage of the process. Remember that during this stage teams should:
  - Select the best idea and explore it in further detail.
  - Create working drawings of the best idea.
- **(Just Do It! Slide)** Say: Teams will have 10 minutes to conduct consumer research, 30 minutes to brainstorm and design your backpacks, and 5 minutes to present the selected design.
- **(Questions? Slide)** Ask the students if they have any questions about the challenge before getting started. Answer questions posed by the students.
- **(Backpack Design Challenge Slide)** Start the challenge by giving the following instructions:
  - Teams have 10 minutes conduct research. During this time, you need to write down a list of questions and get responses from the students not in your group.
  - Once research is done, work as a team to define the problem.
  - I will let you know when the 10 minutes are up.
  - If you complete this step before the 10 minutes are up, you may immediately start brainstorming potential designs.
- After 10 minutes, instruct teams to move on to brainstorming and design. Teams have 30 minutes to brainstorm and design your backpacks.
- During the 40 minutes students have to conduct research and design their backpacks, circulate around the room asking students questions about their designs. While you may be tempted to give suggestions for improvement, hold on to the suggestions until the reflection period of the activity, to give students the opportunity to work through the process with their teams.
- Keep teams informed of the time remaining; provide a warning at 10-minutes and 5-minutes remaining.

5. **Team Presentations (30 minutes)**
    - Reconvene the large group.
    - **(Team Presentations Slide)** Explain: It is now time for teams to present backpack design to the group. Remind the students each team has 5 minutes to present its design to the group.
    - Ask for a team to volunteer to be the first presenters. Request that the presenters stand where everyone in the room can see them.
    - After each presentation, allow students time to ask the presenting team questions.
    - Provide brief feedback on the design presented and ask the team questions you may have on their design. Consider asking any of the following questions.
        - What did you learn while conducting research with potential consumers?
        - What was the most critical decision your team made during the design of your backpack?
        - What was difficult about designing your backpack?
        - What would you change about your design if you were to do it again?
    - Repeat the process until all teams have shared their designs.
    - **(Reflection Slide)** Ask students to reflect on the activity. Have students spend a few minutes thinking about the following questions and responding:
        - What did you learn about design?
        - How do you think this activity relates to a career in design and/or working at Johnson & Johnson?
        - Can you see yourself as a STEM²D professional? In what role? Why or why not?
        - What would you need to do to make that happen?
        - What is one thing you learned that you did not know coming into today?

Extended Learning

Here are a few ways to extend the learning:

- Encourage students to continue the design process by building and testing their backpack designs.
- Conduct **Building a Prosthetic Arm** (a WiSTEM²D Student Activity focused on design and manufacturing) https://www.stem2d.org/prosthetic
- Implement **Create It, Try It, Manufacture It** (a WiSTEM²D Student Activity focused on design and manufacturing) https://www.stem2d.org/activities/#makeit
- Try **Cotton Ball Catapult** (a WiSTEM²D Student Activity focused on design and engineering) https://www.stem2d.org/activities/#catapult

Key Words

- **Aesthetic:** a pleasing appearance or effect
- **Consumer:** a person who purchases goods and services for personal use
- **Design:** creating, constructing, or inventing an object, plan, product, or system; it is also a human-centered mindset and collaborative approach that results in better experiences by uncovering unmet needs and championing meaningful relationships through user-friendly products, environments, and systems
- **Design Thinking:** an approach or process focused on solutions to user concerns or problems
- **Model:** a miniature representation of something
- **Utility:** the quality or state of being useful

Resources and References

The following resources provide additional information or activities:

- Automation, Innovation, and Business—STEM for Kids: https://stemforkids.net/programs/advanced-manufacturing/
- Introducing the Design Process: https://pbskids.org/designsquad/pdf/parentseducators/DS_TG_DesignProcess.pdf
- Tackle the Engineering Design Process—with Kids! https://stemactivitiesforkids.com/2016/02/25/690/
- Video: The Engineering Design Process—A Taco Party: https://www.youtube.com/watch?v=MAhpfFt_mWM
- Video: Kid Engineer The Design Process Design Squad: https://www.youtube.com/watch?v=FuzmxrqqBLc

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The following checklist helps activity leaders plan and prepare to conduct the Backpack Design Challenge *activity with students.*

DID YOU…

- ☐ 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. Download at www.STEM2D.org.*

- ☐ Visit the implementation site and observe the young people? (optional) If so, take note of the following:
  - ☐ How does the site encourage orderly participation? For example, do the young people raise their hands when responding to questions or during discussions? How are interruptions handled? Do you see any potential problems with managing the class of young people?
  - ☐ What does the site do to make each student feel important and at ease?
  - ☐ How is the room arranged? Will you need to move desks or chairs for any part of your presentation?
  - ☐ How can you engage the site representative in your presentation?

- ☐ Meet with and finalize the logistics with the site representative?
  - ☐ Confirm the date, time, and location of the activity?
  - ☐ Confirm the technology needs? Do you need to bring a computer and a projector to show the PowerPoint? Or, does the site have one that you can borrow? Does the site have Internet access? Can you use it during the activity to show the videos?
  - ☐ Confirm the number of students attending? Knowing this will help you decide how to divide the class into teams and/or pairs, as well as the appropriate 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 and tailor the PowerPoint, if desired, to reflect your background and experiences, as well as the cultural norms and language of the students in your community?
  - ☐ Review the notes section of the slides in the PowerPoint for information to be shared?

- ☐ Complete the Tell My Story Form, which will prepare you to talk about your educational and career path with the students? If desired, include key points about your story on the PowerPoint (see **Tell My Story Slide**).
- ☐ Practice your presentation, including the hands-on, minds-on activity? Be sure to:
  - ☐ Do the activity; make sure you are able to explain the concepts to students, if needed, and that you know the correct answers.
- ☐ Obtain the required materials *(see the **Materials** and **Estimated Materials Costs** sections)*
- ☐ Set up the site appropriately for the activity? Specifically:
  - ☐ Make sure tables and chairs are arranged to accommodate teams of up to three to four students.
  - ☐ If additional volunteers are available, assign adults to specific teams.
  - ☐ Set up the computer and projector for the PowerPoint presentation; be sure that speakers and an Internet connection are available to show the video.
  - ☐ 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!**

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 had your first '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 postsecondary path, including the institution you attended and your degree? *If you switched disciplines, make sure you explain why to the students.* _____

_____

What your current position entails. *Be sure to include how you use STEM²D during a typical work day.* _____

_____

BACKPACK DESIGN CHALLENGE

Student Handout

The Challenge:

Work as a team to design a new backpack that improves the utility, comfort and aesthetic of backpacks currently on the market.

Tasks:

- Follow the first three steps of the design process:
    1. Define the Need
    2. Brainstorm potential designs
    3. Design the new backpack
- Present the completed design to the large group; all team members should have a role in the 5-minute presentation.

Definitions:

- **Aesthetic:** A pleasing appearance or effect
- **Consumer:** A person who purchases goods and services for personal use
- **Utility:** The quality or state of being useful

Materials:

- Paper
- Poster board
- Markers/crayons

Instructions:

Step 1: Define the Need (10 minutes).

Create a design based on the needs and desires of the consumer by conducting research. This can be done by asking questions of potential consumers. For example, you could ask consumers: What would you like to carry in your backpack? As a team:

- Come up with four questions to ask potential consumers.
- Ask the questions of the students in the class who are not on your team (your potential consumers). Get four to five answers to each question.
- Review the responses and describe the problem you're trying to solve.

Step 2: Brainstorm (10–15 minutes).

Think about different ways to design a backpack that addresses the needs of consumers and solves the identified problem. As a team:

- Draw, sketch or write down your ideas.

Step 3: Design (15–20 minutes).

Design the backpack! As a team:

- Select the best idea and explore it in further.
- Create working drawings of the best idea.

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