Young Scientist Lab

Educator guide

3M Week of Innovation

One week of Innovation Challenges that will inspire learners to consider how to improve the world around them.

OVERVIEW

WHO CAN CREATE INNOVATIONS THAT SOLVE EVERYDAY PROBLEMS?

Many of the greatest innovations of our time were first designed to solve simple problems for which we didn't even know we needed solutions. This challenge was designed to encourage young people to consider how they can solve everyday problems using science and innovation. Throughout this week of innovation, students will be asked to be curious and consider how they can make the world a better place for future generations.

Students will engage in innovation challenges that have them consider how they can create an innovation that improves the world around them. Students will be asked to work in small groups while practicing collaboration, communication, critical thinking, and creativity. They will do this by working in various station activities throughout the week. These station rotations will support students as they consider the idea that they want to create for the 3M Young Scientist Challenge. Students will be given suggestions and opportunities to begin considering and creating their submission video for the 3M Young Scientist Challenge. Remember that students must get parent permission prior to submitting their video and students must create their own submission without the help of their peers. Their submission needs to be in the form of a 1–2-minute video that shares why they were inspired to solve a chosen problem, and how they developed a concept that uses science to improve the lives of future generations.

Their idea must be a new innovation and cannot simply be a new use for an existing product. All innovation challenges are designed around 3M Young Scientist Challenge entry topics:

1. Robotics
2. Home Improvement
3. Automotive
4. Safety
5. AR/VR
6. Climate Tech

TIME FRAME

Approximately eight 45-minute class periods

NATIONAL STANDARDS

Next Generation Science Standards

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Common Core Math Standards

Expressions and Equations

- Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

Statistics and Probability

- Use random sampling to draw inferences about a population.
- Draw informal comparative inferences about two populations.
- Investigate chance processes and develop, use, and evaluate probability models.

ISTE Standards

1.1 Empowered Learner

Students leverage technology to take an active role in choosing, achieving, and demonstrating competency in their learning goals, informed by the learning sciences.

1.3 Knowledge Constructor

Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts, and make meaningful learning experiences for themselves and others.

1.4 Innovative Designer

Students use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.

1.5 Computational Thinker

Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.

1.6 Creative Communicator

Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats, and digital media appropriate to their goals.

TEACHER PREPARATION

- Materials for each station are listed in the station overview below. Each group of students will need access to the materials when they rotate into the station. Calculate the total number of items needed based on the number of students participating.
- Student Recording Pages
- Station Task Cards—printed and possibly laminated
- Table and Station set-up as needed in the classroom
- Bins and baskets as needed to keep in stations for material storage
- Recommended: Lab notebooks and pencils for each student
- Access to iPad or other mobile device for video recording and practice

COMPREHENSIVE MATERIALS LIST

- Station Task Cards—printed and ready (laminated if possible)
- Printed Student Recording Pages
- Modeling clay (reusable, air-dry, or oven-dry)
- Drinking straws
- String
- Tweezers
- Small rubber bands
- Paper clips—plain and plastic coated
- Scissors
- Needle
- Cardboard tube
- Assorted objects to grasp (suggested items: ping pong balls, small toys, and other light objects)
- Paper and pencil
- Raw eggs (before using raw eggs in the classroom, ensure students do not have an allergy to eggs)

- Paper towels
- Assorted craft and construction materials such as popsicle sticks, paper cups, egg cartons, cardboard, etc.
- Cushioning materials like cotton balls, bubble wrap, Styrofoam®, etc.
- Tape
- Area to drop the egg to simulate impact, that will be easy to clean up in case the egg breaks
- Newspaper for drop zone
- Plastic for drop zone
- Sticky Notes
- Pizza box or large box
- Rulers
- A sheet of black paper
- Utility knives (review safety rules with students prior to usage)
- Aluminum foil
- Plastic wrap
- Shipping tape or black electrical tape
- A wooden skewer or pencil
- Sunlight and fairly warm outside temperatures (above 75 degrees Fahrenheit is recommended, and the hotter it is the better)
- S'mores ingredients (optional): graham crackers, marshmallows, and a chocolate bar
- Pennies
- Water
- Dishwashing soap
- Plate
- At least one lemon (preferably with a thin skin)

CLASSROOM MANAGEMENT RECOMMENDATIONS

- **Expectations:**
  - Be very explicit in expectations as to what will be covered at a station. The goal is to have students be independent during this time.
  - Make sure that directions (Station Task Cards) are printed and clearly posted in each station. You may want to print them on card stock and laminate them, if possible, so they are more durable.
  - Students should carry their lab notebook and pencil with them to each station for recording notes and project ideas.

- Rotate through stations, if you have a 45-minute class period, you will have time for one station per day, when factoring in station completion and clean-up. If you have flexibility in your schedule, you can have students rotate through two stations per day.
- There are 8 stations for this Innovation Challenge preparing students for the 3M Young Scientist Challenge. The last two stations are intended for preparing to submit an entry.

- **Materials:**
  - To ensure independence at each station, make sure to keep materials organized and on hand. Having materials in bins and baskets ready at the onset of each rotation will limit interruptions in the challenges and allow you to be able to circulate among your students to monitor them and answer questions. Be sure to enlist students to clean up and make sure materials are restocked as needed for the next group. Note: If students become finalists, they will need to know how to manage their own supplies during the final competition.
- **Accessible:**
  - Everything needed at the station should be student accessible. Unless it's a teacher-led station, students should have easy access to all the materials needed for the task.
  - Students should not need to rely on the teacher to grab materials for the station time in order to promote independence within each station.
  - Have a designated area in the room where all required materials are set up. If it's not possible to leave materials out in between classes, have previous classes help set up before they leave. Consider adding items to stations while the previous class is in their clean-up stations. Use that time wisely and creatively.
- **Time Management:**
  - Use a timer that the class can see. Online timers are available that allow you to project the time remaining in the class period. This is a good way to promote time management and helps ease transitions for students, especially for students who have a hard time with transitions.
  - Some students will want to keep working at their station and not switch. Having a visual timer can help all students prepare for the next steps and what they can accomplish in the given time frame.
  - If students feel that there is not enough time at their station, consider repeating the stations again or allowing additional time to complete the station.
- **Manage Learners:**
  - Keeping track of where the kids are is vital to the success of station rotations.
  - Someone might be absent one day or get pulled from class. To manage this, write the names of the kids in the group on the whiteboard or on a station rotation digital chart.
  - This will ease rotation management and allow you to know who completed what station.

- **Clean Up:**
  - Students need to clean up fully before rotating. Remind each group that they need to ensure all the materials are put away correctly the way they found the station. Having cleaning wipes handy is helpful. This is also a great time to ensure that stations are restocked.
- **What to Do When Students Finish Early:**
  - Each station has extra material you can share: What Happened, Digging Deeper, For Further Exploration, and Inspiration from 3M Young Scientist Challenge Alumni that they can explore further.

Make a Robot Hand

Station 1: Robotics—Innovation Challenge

ACTIVE TIME
20–30 minutes

TOTAL PROJECT TIME
20–30 minutes

KEY CONCEPTS
Robotics, engineering, prosthetics

TEACHER NOTE
Adult supervision is required for oven-bake clay. Placing plastic drinking straws in the oven may cause them to melt depending on the baking temperature of the clay. If you notice any funny smells or see your straws melting, immediately turn off the oven and remove the robot hand.

TEACHER PREPARATION
Print Station 1 Task Cards (slides 3–11) from the Student Task Card Week of Innovation Slide Deck. Consider laminating the task cards to lengthen the life of the cards.

INTRODUCTION TO STATION
Do you know anyone who has had a hand or an arm injured in an accident? What if you could build them a robotic hand to help them accomplish everyday tasks like writing, picking up a glass, or opening a door? This activity will show you how to build a simple robotic hand using common household materials.

MATERIALS
Note: This is an engineering design project. The procedure will show one way to build a robotic hand, but this is just a suggested list of materials to get you started. Modify the design and substitute other materials as needed.

- Station Task Cards—printed and ready
- Modeling clay (reusable, air-dry, or oven-dry)

- Drinking straws
- String
- Tweezers
- Small rubber bands
- Paper clips
- Scissors
- Needle
- Cardboard tube
- Assorted objects to grasp
- Other items to have in your station for testing your hand: ping pong balls, small toys, and other light objects.

Teacher Note: Make sure that materials are organized in bins and containers for students to access during station work time. Be sure that supplies are restocked before the next station rotation for the next students to access.

Scrambled Brains—Create a Better Helmet

Station 2: Safety—Innovation Challenge

ACTIVE TIME

30–45 minutes

TOTAL PROJECT TIME

30–45 minutes

KEY CONCEPTS

Energy, force, physics, engineering design

TEACHER PREPARATION

Print Station 2 Task Cards (slides 12–17) from the Student Task Card Week of Innovation Slide Deck. Consider laminating the task cards to lengthen the life of the cards.

INTRODUCTION

The egg-drop project is a classic and time-honored tradition in many science classes. The goal is usually to build a device that can protect an egg when dropped from a high location. This activity puts a twist on the classic project, motivated by real-world concerns in the area of sports. Can you build a reusable egg-drop helmet that can survive impact or repeated falls from the same height? Try this activity and find out.

MATERIALS

- Station Task Cards—printed and ready
- Paper and pencil
- Raw eggs
- Paper towels for cleanup
- Assorted craft and construction materials such as popsicle sticks, paper cups, egg cartons, cardboard, etc.
- Cushioning materials like cotton balls, bubble wrap, Styrofoam®, etc.
- Tape and/or glue

- Area to drop the egg to simulate impact that will be easy to clean up in case the egg breaks
- Newspaper for drop zone
- Plastic for drop zone

How Do Self-Driving Cars Know What to Do?

Station 3: Automotive—Innovation Challenge

ACTIVE TIME

30–45 minutes

TOTAL PROJECT TIME

30–45 minutes

KEY CONCEPTS

Flowcharts, algorithms

TEACHER PREPARATION

Print Station 3 Task Cards (slides 18–30) from the Student Task Card Week of Innovation Slide Deck. Consider laminating the task cards to lengthen the life of the cards.

INTRODUCTION

How do driverless cars know what to do at an intersection? How do they know when they should stop and when it is their turn to go? What about yielding to pedestrians? In this activity, you will write your own algorithm, or list of steps, for a driverless car to follow when navigating through various road scenarios like stop signs, traffic lights, and roundabouts (traffic circles).

MATERIALS

- Station Task Cards—printed and ready
- Paper and pencil or a whiteboard/chalkboard
- Optional: Sticky notes

Teacher Note: This station has task cards containing background reading. Please be sure to include them when you print the cards.

Build a Solar Oven

Station 4: Climate Tech—Innovation Challenge

ACTIVE TIME

20–30 minutes

TOTAL PROJECT TIME

45 minutes to 1 hour

KEY CONCEPTS

energy, solar power, sun, heat, cooking, recycling

TEACHER PREPARATION

Collect and, if needed, clean out the pizza boxes so you have them ready to become a solar oven. Remove any cardboard liner that the box came with. Many pizza businesses will donate unused boxes if asked.

Adult assistance is recommended for using the utility knife. Use caution when cooking with the solar oven as it can get quite hot!

Print Station 4 Task Cards (slides 31–37) from the Student Task Card Week of Innovation Slide Deck. Consider laminating the task cards to lengthen the life of the cards.

INTRODUCTION

Have you ever cooked something outside, like for a BBQ or while camping? It can be a lot of fun to be outdoors and enjoy eating the fruits—or burgers—of your cooking labors. Did you know that you can directly use solar power to cook food? This can be done using a solar oven, which is a low-cost, ecologically friendly technology that seems to have everything going for it. In this science activity, you will build your very own simple solar oven out of a pizza box to gather the sun's rays and cook a tasty treat!

MATERIALS

- Station Task Cards—printed and ready
- Pizza box. The larger the box, the better the oven should work.
- Pencil or pen

- Ruler
- White school glue
- A sheet of black paper
- Utility knife
- Aluminum foil
- Plastic wrap
- Shipping tape or black electrical tape
- A wooden skewer or pencil
- To do some cooking with your solar oven, you will need sunlight and fairly warm outside temperatures (above 75 degrees Fahrenheit is recommended, and the hotter it is the better). It should also not be windy.
- If you want to cook some s'mores in your solar oven, you will also need graham crackers, marshmallows, and a chocolate bar. You can use an aluminum pie pan or a small piece of aluminum foil as a tray.

Juicy Electricity with a Lemon Battery

Station 5: Home Improvement—Innovation Challenge

ACTIVE TIME

20–30 minutes

TOTAL PROJECT TIME

20–30 minutes

KEY CONCEPTS

Robotics, engineering, prosthetics

TEACHER PREPARATION

Wash pennies in soapy water, then rinse and dry them off with a paper towel. This will remove any dirt sticking to the pennies. Print Station 5 Task Cards (slides 38–47) from the Student Task Card Week of Innovation Slide Deck. Consider laminating the task cards to lengthen the life of the cards.

INTRODUCTION

Can you imagine how your life would change if batteries did not exist? If it were not for this handy storage of electrical energy, the radio in a car would not function, nor would the lights. A pacemaker or hearing device would need to be plugged into a wall outlet in order to function, and do not forget all portable electronic devices like phones, digital music players, or tablets are all powered by batteries.

With all the frustration you might have endured coping with dead batteries, it might surprise you how easy it is to make one out of household materials. Try out this activity, and it might just charge up your imagination.

MATERIALS

- Station Task Cards—printed and ready (can also laminate)
- Pennies
- Water
- A few drops of dishwashing soap

- Paper towels
- Aluminum foil
- Scissors
- Ruler
- Plate
- Knife
- At least one lemon (preferably with a thin skin)
- Plastic-coated paper clips (2)

Make It All Better

Station 6: AR/VR—Innovation Challenge

ACTIVE TIME
30–45 minutes

TOTAL PROJECT TIME
30–45 minutes

KEY CONCEPTS
Augmented Reality (AR), Virtual Reality (VR)

TEACHER PREPARATION
Print Station 6 Task Cards (slides 48–52) from the Student Task Card Week of Innovation Slide Deck. Consider laminating the task cards to lengthen the life of the cards.

INTRODUCTION
How can we visit another country or location without ever leaving our classroom? How would using AR/VR to discover in science and other subjects change what and how we learn? In this station you will consider how to make a difference in the world around you using AR/VR and learn how it is being used by industry professionals right now.

MATERIALS
- Station Task Cards—printed and ready (can also laminate)
- Devices connected to internet
- Blank paper, pencils, markers and/or color pencils to capture ideas

Station 7: Creating Your Entry

TOTAL PROJECT TIME

20–30 minutes

MATERIALS

3M Young Scientist Challenge Project Template

Teacher Preparation

Print a copy of the 3M Young Scientist Challenge Project Template for each student so they can have the template moving forward.

Print Station 7 Task Cards (slides 53–55) from the Student Task Card Week of Innovation Slide Deck. Consider laminating the task cards to lengthen the life of the cards.

Station 8: Creating Your Video

TOTAL PROJECT TIME

20–30 minutes

Wondering what it takes to make a winning video? Get the scoop straight from past 3M Young Scientist Challenge finalists here.

TEACHER PREPARATION

It would be helpful to have a copy of the Storyboard template printed for each student so they can have the template moving forward.

Print Station 8 Task Cards (slides 56–58) from the Student Task Card Week of Innovation Slide Deck. Consider laminating the task cards to lengthen the life of the cards.

Optional Activity

Creating Your Entry Pitch Mini-Challenge

TOTAL PROJECT TIME

Each student shares their practiced video one-to-two-minute script to the class.

45–60 minutes—depending on the number of students

Students share their entry video script with the class to elicit feedback and constructive suggestions in order to revise and improve their entry.

Print or create digital feedback forms for students to record speaker feedback.

Challenge Resource

Storyboard

Directions: Once you have chosen a topic, researched, and found a solution, begin planning the contents of your video submission. Remember, your video must communicate how your innovation will improve lives for the future and showcase your passion! For more challenge video tips, visit: challenge video tips.

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Challenge Resource

Challenge Project Template

Step 1: Making Observations

Look around you; think about problems you see in the newspaper, on social media, or TV. **Action:** Make a list of observations.

Things to think about:

- What kinds of problems are in the news or on social media?
- What kinds of problems do you see in your community every day?
- What kinds of problems do you hear your family members or friends discussing?

Step 2: Identify the Problem

Now that you have made observations, identify the main problem that could be the cause for the observation.

For example: Parents traveling though security have a lot to pay attention to and small children can often walk away when they are not looking. **Action:** Identify a problem for each of your observations.

Things to think about: (For each observation)

- Why does the problem exist?
- What are some of the circumstances that could have led to the problem?
- Who is involved in causing the problem? Is this a problem that affects your community? Other communities?

Step 3: Narrow Down Your Problem

Most problems have solutions, but some can be solved easier than others. Take a look at your list and choose your top three ideas. You might want to do some research to determine which of your problems would have the best possibilities for a solution. Which interests you the most? **Action:** Narrow your list of problems down to 3.

Things to think about: (For each problem) Which problem…

- most interests you?
- seems the most important to help solve?
- provided you with the most facts during your research?
- provides you with the best opportunity to use science to solve the problem?

Step 4: Brainstorming Solutions

Now that you have narrowed down your options, you have to give some serious thought to possible solutions. For each of the problems, try to develop at least two workable solutions. Keep in mind that we are looking for NEW, innovative solutions. **Action:** Brainstorm ideas/ solutions that will impact your problem.

Things to think about: (For each problem)

What is a possible solution that…

- best uses science/innovation?
- best involves something NEW?

Other questions may include:

- Does your possible solution rely on getting the cooperation of others?
- What types of materials might you need to develop your solution?

Step 5: Focus on One Idea

Now it is time to decide. Take a look at all of your ideas. Which one would have the greatest impact on people around you? Which seems the most interesting to work on? Which has the most promise for innovation and creative ideas? Which lends itself the most to the scientific process? **Action:** Pick one idea for solution.

Things to think about:

- Which are you most interested in?
- Which seems to be the most feasible?
- Which solution is best suited to be scientifically explored?
- Which solution involves the most creative idea for an invention?

Step 6: Elaborate on Your Idea

Action: Describe in detail your solution to the problem.

Step 7: Research

Gather as much information as you can about the problem. Has anyone else tried to solve this problem? What are some other solutions that have been tried? Have they worked? Why or why not?

Action: Keep notes about your research.

Things to think about:

- What other solutions to this problem have been tried (if any)?
- Why do you think your solution will work?

- How will the solution you propose help solve the problem?
- What challenges or problems might exist with your solution? How might you overcome them?

Step 8: Your Plan

This is the part of your scientific process that is very important. You have no way of knowing for sure if your idea will work. You must come up with a plan to test it.

Things to think about:

- What does it mean to have a "testable" solution?
- What are the variables involved?
- What are the logical steps to our tests?
- Why is it important to plan?

Your Hypothesis: (A testable solution to a problem)

Experimental Procedure: (What steps would you take to test your hypothesis)

Materials needed: (Make a list of all of the physical things you might need to gather)

Step 9: Conclusions

What do your observations help you to understand about your solution? Many times our conclusion is that we need to go back and try again. This is an important part of the scientific process. If you need to, go back to step 8 and start again. Fill in another planner for each test.

Things to think about:

- What do your results tell you?
- Do you have to refine your solution and test again?
- What changes do you need to make to your plan (if any)?
- How well does your solution affect the problem?

Step 10: Write out a script for your Young Scientist Challenge Submission Video

- Consider using a storyboard to help you plan what you will include in your video.
- Check out challenge video tips from previous winners.
- Don't forget that your video needs to be 1–2 minutes long and can only include you.

Step 11: Submit your video at YoungScientistLab.com!

Mini-Challenge Feedback

	Yes	Needs Work	No	Comments
Idea communicated clearly				
Organized and easy to follow				
Presenter exhibited a good plan for their innovative idea				
Presenter was well-prepared				
Presenter spoke clearly/effectively				
Time for presentation used effectively				
Visuals, graphics, animation, etc. were effective				
Presenter had energy and captured the audience's attention				
The best part of the entry presentation was:				
A suggestion for Improvement:				