

Junior Girl Scouts Robotics Badges Workshop Tutorial

Hello! We are FIRST Tech Challenge Team 10464, The Bionic Tigers, from Loveland, Ohio. One thing our team really focuses on every year is doing outreach activities, particularly STEM activities for youth. Through connections in our community, we started a program in 2017 to offer workshops for Girls Scouts to earn their robotics badges. Our goal in offering these badge workshops is to give girls the opportunity to participate in fun and educational STEM activities and to encourage them to explore STEM opportunities in school and in outside activities such as FIRST robotics programs like FIRST LEGO League Jr, FIRST LEGO League, FIRST Tech Challenge and FIRST Robotics Competition.



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Why focus on programs that provide STEM opportunities for girls? Expertise in STEM fields promotes inventiveness, scientific discovery, and efficiency in the way things are done, while also opening up new jobs and economic opportunities. Due to technological advances, STEM jobs in the United States in the past ten years have grown at three times the pace of non-STEM jobs, and are projected to continue growing at this pace through the next decade. The Girl Scout Research Institute (2012, 2016) studied both girls who enjoy STEM and did not enjoy STEM. The study showed the following:

- Girls are generally confident in their abilities and endeavours. Nearly 97% plan on attending post-secondary school.
- Girls and boys are equally competent in math and science. **74% of girls enjoy STEM-based learning!**
- However, some factors have negative effects on these girls pursuing interests in science and math, such as engineering:
 - Internalizing outdated stereotypes of inferiority to boys in math and science



- Subtle societal and cultural expectations discouraging girls from math and science

Girl Scouts reach 2.4 million girls ages 5-17, making their organization uniquely positioned to address gender equity in STEM education and enrichment across the country. Through program partnerships with various organizations, such as Lockheed Martin, Motorola, the National Science Foundation, NASA, FIRST, and AT&T, Girl Scouts has been committed to providing STEM programming to girls through activities aimed at engaging and cultivating interest in STEM fields. In addition, Girl Scouts of the USA and its councils across the country have embarked on an advocacy initiative to raise awareness about girls' participation in STEM with public officials and community leaders at the local, state, and federal levels. The organization is fulfilling the Girl Scout mission to be the voice for girls by sharing its knowledge and expertise with the larger community to ensure that all girls have what they need to succeed in STEM fields.

Girl Scouts are divided into levels based on grade, and currently, they offer robotics badges for Daisies, Brownies, Juniors and Cadettes. We have Robotics badge programs available for Daisies, Brownies, and Juniors, and we will be working on developing curricula for Cadettes this spring. Daisies are kindergarten and first graders, Brownies are second and third graders, and Junior Girl Scouts are in fourth and fifth grade. Each age level has 3 different robotics badges they can earn.





For Junior Girl Scouts, the badges are:

Robotics



Programming
Robots

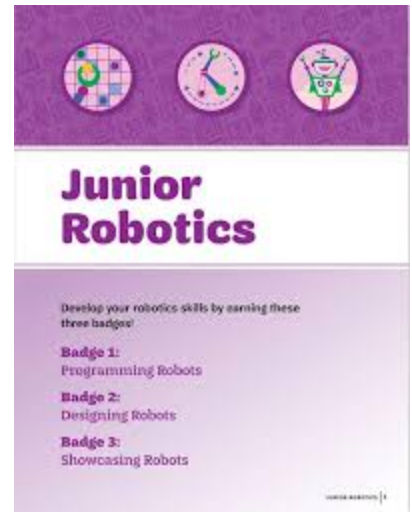


Designing
Robots



Showcasing
Robots

Girl Scouts of the USA has published badge guidelines for each of these badges, and those materials are what we used in developing our workshops. One important thing to remember when doing Girl Scout badges is that girls are required to complete all steps of each badge, and you shouldn't double up and count one activity for multiple requirements. That being said, an activity can be extensive enough to cover more than one requirement, and you don't have to do exactly what is listed in the badge materials. You should have an activity that meets the intent of each step of earning the badge.



The purpose of this video is to share the program we have developed for Junior Girl Scouts to earn their badges so that other robotics teams or Girl Scout troop leaders can offer programs in areas where they live. We have offered monthly programs in Loveland, Ohio and they always fill very quickly, with some people traveling almost 200 miles to participate. We do all three badges for a single age level at each event and the program runs for three hours. If your time is more limited, it would be easy to break the program up into smaller sections and do badges separately. We offer the programs for a minimal cost of \$5/girl in order to cover the costs of the program for supplies that need to be replaced as well as to acquire reusable materials for the badge workshops.



The first Junior badge is called Programming Robots, and it is a favorite of the Girl Scouts who have done our programs.

The steps are:



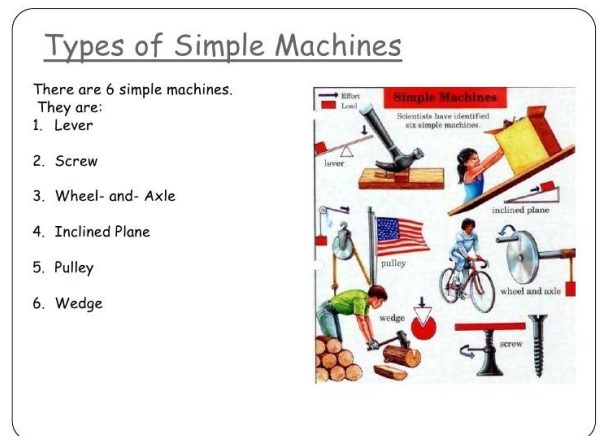
1. Learn how robots work
2. Discover the robot brain
3. Learn about programming
4. Try Simple programming
5. Code a robot

The purpose of this badge is to learn how to create a program that can be run by a robot. Because people usually don't arrive all at the same time, we have found that having a screen set up with videos of real-life robots playing is a good way to start the event. It catches their attention and gets them talking about robots before we start the program. One video we use can be found here: https://www.youtube.com/watch?v=J_8OnDsQVZE

Step 1: Learn How Robots Work.

Robots are machines that do a task or multiple tasks automatically. They are used to do many tasks that humans don't want to do or can't do, such as repetitive tasks or work in harsh or dangerous environments.

From the GS Badge requirements "Robots are made up of many different pieces like gears, levers, sensors, and wires, that protect them and give them directions on how to act, move and respond to different situations. Learn about the Mars Rover and simple machines as you create a "Safety Lander" that can land a Rover without damaging the robot."



- There are many videos of the Mars landers you can show to introduce Girls what the Mars lander and Mars Rover are. Find one that is fun and engaging to use.
- We also include a review of simple machines and show examples of real life simple machines that people use in everyday life to help the girls learn to identify them. This graphic is a helpful illustration to put up when discussing simple machines
- To build their own lander, have the Girl Scouts build something to protect an egg or small item from a controlled drop. You can do this with arts and crafts materials or building materials like K'nex.



Step 2: *Discover the Robot Brain.*

Without instructions to tell them what to do, robots are just simple machines. Computer engineers, or programmers, create algorithms, or sets of step-by-step instructions, that are coded into the robot's "Brain" so they can move and act automatically. The computer or robot brain works similarly to our brains, with parts that help us to see, understand, and react to our environment. Relay messages with your fellow Juniors to discover how robots send and receive messages between different parts of their body.

- We have used a couple different activities here:
 - Break the girls into groups of 5-6 people and have them organize themselves in order alphabetically by first name or last name without talking.
 - Then put all the small groups together and challenge them to organize the large group in the same way.
 - Discuss how they were able to relay messages without talking.
 - Another way they can organize themselves are by birthday, or you can have them relay a specific message down a line without talking, a version of the old telephone game.

Step 3: *Learn about programming.*

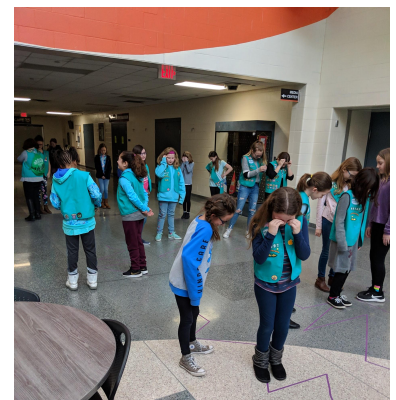
Programmers create algorithms that instruct robots on how to move and react. Do you think you could create a program to instruct a "Robot" friend? Create a program on paper to help a fellow Junior, your "robot", to build an image made of tangrams, and learn about algorithms and computer programming.

- Introduce the term algorithm and explain what it is - a set of step by step instructions for how to do something,
- Ask the Girl Scouts for examples of algorithms they use in everyday life. Some examples to offer are a recipe for making cookies, doing a math problem like long division, following directions for how to get somewhere.
- Do an interactive activity where girls make an algorithm to get a fellow Girl Scout to accomplish a task. You can have them make an image out of tangrams, draw a picture of something copying a set example, or guide a friend through a maze.

Step 4: *Try simple programming.*

Programmers translate their algorithms, sets of step-by-step instructions, into a special code that can be understood and run by robots. Create your own special programming language to create step-by-step algorithms for your robot to stack cups that could be run over and over again.

- We build on our activity in Step 3 for this and have the girls develop a specific set of instructions that can be used.
- For example, to guide your friend through a maze, come up with a simple set of commands you can use:
 - Walk forward
 - Turn Right





- Turn Left
- Stop
- Make sure the girls understand that they have to follow the direction given to the letter. For example, if you are told to turn right, you keep turning right until your programmer tells you to stop.
- Give each girl a chance to be the programmer and the robot.

Step 5: *Code a robot.*

Engineers program their robots to move, act and understand. Now is your chance to code on a device, like a table or computer and complete an Hour of Code. Choose a game from the site and program your robot or character to complete the tasks. Remember no matter what game you play, you could give the same instructions to a robot, just like you are giving instructions to the game characters. Your algorithms could be coded into a robot.



- We are fortunate to be able to use a set of LEGO NXT robots owned by our school for this activity, so girls are able to code actual robots.
- We build identical NXT robots ahead of time, including a light sensor, and work with the Girl Scouts to teach them NXT programming including moving forward, turning, and repeating a motion with a loop until the light sensor detects a line.
- We lay out a path on the floor with tape lines and let the girls work in small groups to program their NXT to move along the line and stop when it detects a different color line at the end of the path.
- Introduce the term debugging and explain how to fix problems with your code.
- If you have NXT robots or something similar, make sure to allot enough time for this activity. We give each group a full hour working with the NXT robots so they have time to learn and do through multiple iterations.
- If you don't have NXT robots to use, there are many great options to use at hourofcode.com. You may need to ask troops and girls attending to bring a device to work on if you don't have computers available.



The second Junior Robotics Badge is Designing Robots.

The steps to earn it are:

1. Discover the future of robots
2. Determine your robot's expertise
3. Plan your robot
4. Create a prototype
5. Get feedback on your robot

The purpose of this badge is to learn how to design a robot that solves a global problem.

Step 1: *Discover the future of robots.*

A lot of the time, we think of robots as shiny metal figures that look like us, with heads, bodies, arms and legs. Biomimicry is when an engineer makes a machine that looks and acts like a human, animal, or plant. Engineers study how humans and animals look and act to brainstorm creative ways to design their robots. Artificial intelligence is when robots or other machines are programmed to learn and adapt to their environments over time. Explore what makes something intelligent and learn how artificial intelligence can help solve global problems.

- Biomimicry is used in a lot of robot examples you can show from videos. Some we use are an underwater robot snake that can make mechanical repairs, a Boston Dynamics robot that can open doors, and a robot bat that flies like a bat.
- Explain what Artificial Intelligence is
- Ask the girls if they know any examples where robots are used and might use AI. Some examples you can share:
 - Automotive - many robots are used to assemble and test vehicles
 - Healthcare - robots are used in surgery and helping take care of patients
 - Space - robots are used to explore space and other planets, like the Mars Rover
 - Mining - robots are used to scout areas for excavation and can go places where it isn't safe for humans
 - Safety - robots can be used to work in areas where it isn't safe for humans, such as with hazardous waste or in dangerous situations
 - Manufacturing - robots are used to create parts, assemble, move and pack products. They can do many repetitive tasks much more efficiently than people.

Step 2: *Determine our robot's expertise.*

Just like engineers create step-by-step programs for robots to follow, algorithms are a way we can share our talents and teach each other to do something we are good at. Think about what you could teach others to do and create a program for your talent. Then work with your fellow juniors to brainstorm ways to add technology and innovation to solve problems and teach others.

- We have each girl work with a partner for this activity.



- Give them a few minutes to think about what they are good at and write down a basic algorithm for how to do it.
- Now how could you add a robot or computer to the activity to help teach someone?
- Share your algorithm and technology plan with your partner

Step 3: *Plan your robot.*

Engineers look for needs in our world and build robots that solve problems both big and small. If you could build a robot that solves a global problem, what would your robot do? What would it look like? What parts would it need? Brainstorm and sketch your ideas for robots that can help others. Share your sketches with other Juniors to improve your designs and choose one to create a prototype of in Step 4.

- Ask the Girl Scouts to share some ideas of problems that robots could solve. They tend to come up with problems that they can relate to in their personal lives (e.g. cleaning your room, doing your homework)
- Encourage them to think of bigger issues in the world as well.

Step 4: *Create a prototype.*

Engineers create prototypes, a quick way to show an idea to others or try it out. It can be as simple as a drawing or created with common materials, such as cardboard, paper and string. Now is your chance to build a prototype of your robot. Remember, you're creating a robot, not a simple machine, so you'll also need to create a step-by-step program for your robot prototype to run.

- We have used different materials for prototyping, and both are good options.
 - One is to use simple craft materials like cardboard, string, tape, and paper. Recycled materials like plastic lids and straws are also helpful. If you use craft materials, it is a good idea to pre cut cardboard into manageable size pieces and have strong scissors available for girls to use. Having round items to use for wheels is also helpful.
 - The second option is to use building materials like K'nex for prototyping. If you are using a reusable option like this, make sure to have enough pieces available to give the girls plenty of building options.
- For this activity, we have the girls work in small groups of 3-5 girls with a member of our team as an advisor. Together they can decide on which idea they want to prototype and brainstorm ideas of how to build their robot. Our team members help make sure everyone is included and guides the discussion as needed.
- Give the girls plenty of time to work on building their prototype and writing their program for the robot to perform its tasks.





Step 5: *Get feedback on your robot.*

Once engineers create a prototype, they test it to find ways to improve and redesign their new products. Work with a fellow junior to test your robot prototype. Tell your partner how to move the prototype according to your program so you can debug or fix problems before you share your prototype with your troop. After you share, gather feedback and ideas like an engineer on how to improve your robot's design and make it even better.

- We have the small groups share their prototypes with a team member or another small group to get feedback on their ideas.

The third Junior badge is Showcasing robots.

The steps to earn it are:

1. Create a presentation to share how you designed your robot
2. Tell others how you designed your robot
3. Learn about robotics competitions
4. Learn about robotics teams
5. See robots in action



The purpose of this badge is to learn how to share your robot with others.

Step 1: *Create a presentation to share how you designed your robot.*

After an engineer creates a prototype, she shares it with others. This is important because it gives her a chance to share her work, get feedback and teach others how to build their prototype. Choose a way to share your prototype and explain how you designed it.

Option 1: Create a media presentation (video, photo collage)

Option 2: Create a show-and-tell presentation

- For this step, we have the design groups work together and present their robot prototype to the large group.
- They include the problem they are creating a robot to solve, how their robot works and plan to demonstrate it.
- We encourage leaders to videotape the presentations of each group.

Step 2: *Tell others how you designed your robot.*

Once you've created your presentation, it's time to share what you've made with an audience. Sharing your work is an important part of being an engineer. It's your chance to teach, inspire and get feedback to improve your robot.

Option 1: Share your video or presentation at a troop celebration for family and friends.



Option 2: Give a show and tell a presentation at a school or community event.

- Each group presents to the large group to share their prototype and demonstrate their robot.
- Leaders are encouraged to videotape the presentation to take back to share with family and friends as well as other troops.

Step 3: *Learn about robotics competitions*

There are a lot of places where you can meet other people who design robots. At robotics competitions, teams of engineers build robots that can navigate mazes, lift heavy objects, and solve other problems. Teams are posed with challenges then design prototypes to solve the problem using robotics kits. Competitions like these are held around the world. Girls like you can sign up to join a robotics team to engineer and design robots. Choose a way to learn more about robotics competitions:

Option 1: Go to a competition or science fair.

Option 2: Talk to someone who competed.

Option 3: Learn about competitions online

- Our team shares with the Girl Scouts how their robot competitions work. We show video of the competition design and talk about how we work together as a team to design and build a robot to compete.
- We show videos of our robot in action.



Step 4: *Learn about robotics teams.*

Robotics teams are made up of dedicated members, each with their own talent or expertise to bring to the robot, from programming to driving to marketing the robot. Robotics teams work together, listen to each other, and make sure to be safe when creating their robots. Now that you've seen what teams do at robotics competitions, consider if you'd like to join a robotics team.

- **Option 1:** Join or create a robotics team in your area.
- **Option 2:** Talk to someone who has been part of a team.
- **Option 3:** Learn about robotics teams online.
 - Our team is split into 3 subteams, build, programming and business. We take time with the girls and talk about what members in each team do and share how that matches with their interests.



- We give Girl Scouts an opportunity to ask team members questions to learn more about our team.

Step 5: *See Robots in Action.*

See a robot in action and reflect on everything you've learned. What does the robot do? What sort of parts do you see in the robot? Discover how engineers bring robots to life.

- **Option 1:** Go on a field trip and see a robot. Find a robotics team with a robot, perhaps at the high school or local college, and visit their workspace. You can also visit a local business and learn how they use technology and/or robotics in their work. Explore the lab or watch the robot to see how a robot looks in action. Ask the engineers or business how the robot works.
- **Option 2:** Talk to someone who has been in a lab or used a robot. Talk to an older girl, a robotics team coach, a GS volunteer, or anyone else who has been in a robotics lab or used a robot. Before they arrive, brainstorm questions to ask them about their experience.
- **Option 3:** See a robotics lab online. With help from your parents or leader, search online for Robotics Lab Virtual Tours to find videos and virtual tours of robotics labs around the world. As you look around, point out what robotics team members are working on and any robot parts you see.
 - We demonstrate our robot for the Girl Scouts to show them how our competition robot completes tasks.
 - Since we hold our workshops in our high school, we can also show the girls our robotics room where the team works.
 - We also have a demonstration robot that we can let the girls drive.