KitHub

kithub.com

Motorized ArtBot

Lesson Plan for Grade Level 6-8

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Welcome

Thank you for choosing KitHub. Our programs enable learners to foster a more in-depth understanding of a range of subjects and interest areas and build confidence by asking questions and investigating ideas independently. Hands-on activities teach learners to iterate and revise designs and document their experience to encourage peer learning. The projects are open-ended so that learners can remix them based on themes and interests they enjoy. Most KitHub projects can be completed without a digital device; however, most include extensions for programming, graphic design, and physical computing.

Online Courses For Learners

We have created online courses for learners that complement this lesson plan and the kit instructions. The sessions go in-depth in many subject areas and include wellness breaks, additional project ideas, and troubleshooting guides. The coursework is printable for those learners without access to a web-enabled device. You can find courses and kits at https://kithub.com.

Interest Pathways

For an interest-driven approach to learning these subjects, we have created learning pathways focused on themes, including music, games, fashion, and storytelling. You can find thematic programming at https://kithub.com.

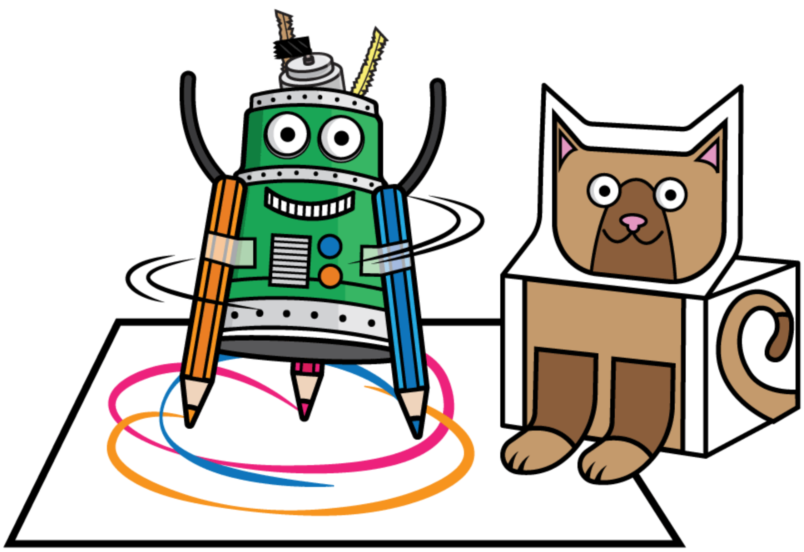
Disclaimer

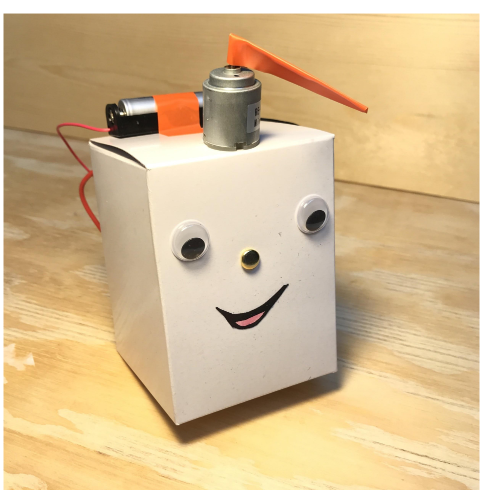
Neither KitHub nor any other party involved in creating this curriculum can be held responsible for damage, mishap, or injury incurred because of this lesson. We recommend adult supervision at all times.

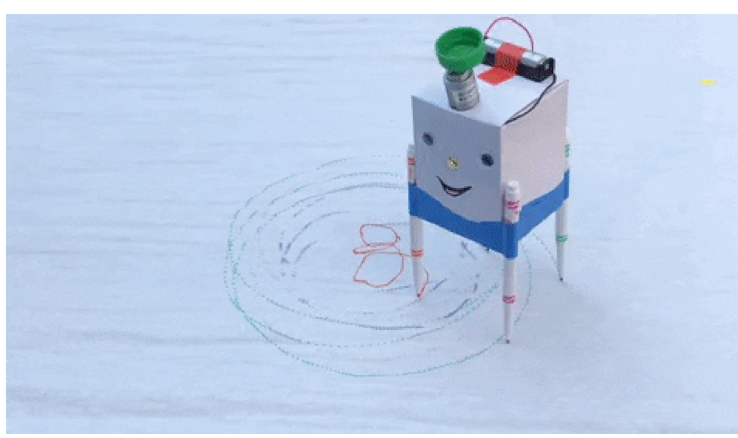
⚠ **Important!**
Products may include small parts and are not for children under three years old. Products may be a choking hazard. Proceed with caution when dealing with electronic circuits. Adult supervision is required.

Introduction

In this lesson, students will work in teams to use the engineering design process to design, build, and test a robot with a simple electric circuit using the materials from the KitHub Motorized ArtBot kit. After completing their robots, teams will square off in a BattleBot-type tournament to see which BotBot will rule. This lesson can be completed as a day-long cross curricular activity or can be split up over several days.







Preparation

KitHub provides instructions and tutorials online to help facilitators become familiar with the materials. This lesson is a simple introduction to electricity and circuits, but it might be helpful to have a deeper understanding before you begin. Please refer to KitHub's *Vocabulary for Facilitators - Energy and Electricity Basics*.

The engineering design process used in this lesson is (a flowchart that can be shared with students can be found in the Resources section of this lesson plan):

1. Identify the need
2. Research
3. Brainstorm and design
4. Select and build the best solution
5. Test, evaluate, and redesign
6. Share solution and final test

Prior Knowledge

Learners should have basic listening skills and group work skills. Learners should know the procedures for working with materials alone and in groups and be able to follow appropriate safety routines. In addition, students should know how to make simple and parallel circuits and have a basic understanding of electricity. This lesson assumes that the student has had an introduction to engineering and using a design process, but the lesson could easily be adapted to serve as an intro to engineering concepts. Learners should also have experience with internet and library research.

Before Teaching This Lesson

- ❏ Review the KitHub tutorials and instructions online. These can help you better understand the materials, directions, and goals for this activity.
- ❏ Review KitHub's *Vocabulary for Facilitators - Energy and Electricity Basics*
- ❏ Review the step-by-step directions for building a motorized bot. Follow the directions and make your own bot to learn how the item is assembled and to practice troubleshooting. This will help you be able to answer questions your students may ask.

- ❏ Read this lesson plan in its entirety and gather and/or prepare all materials needed.
- ❏ If your students are new to electronics and circuit building, take time to complete the *Basic Circuit: Light an LED* and *Conductors and Insulators* lessons. Each of these lessons should take 45-60 minutes each to complete.
- ❏ If your students have built simple circuits already, your students should have the skills they need to complete this lesson.

Vocabulary

Additional vocabulary can be found in KitHub's *Vocabulary for Learners*.

Circuit - an electric circuit is a path that allows electrons to flow.

Current - the flow of charged particles.

Electricity - the flow of electrons from one atom to another.

Electron - a subatomic particle that has a negative charge.

Energy - the ability to cause change.

Engineer - a person who designs and builds things.

Engineering Design Process - a series of steps engineers use to solve a problem.

Force - an object's mass multiplied by its acceleration.

Robot - a machine that is designed and programmed by humans. Robots are often designed to solve a problem or make doing something easier.

Additional Information

- The battery doesn't store or create electricity, it provides a source of energy to get the electrons flowing. When a battery becomes "dead", it's not because it lost its charge, it's because the chemicals that create the energy have all reacted.

- Electrons aren't necessarily moving very quickly; the energy is. Imagine flicking a marble at the end of a row of marbles— the marbles may only travel to the next one and stop, but the energy from the flick moves quickly.

- An electric current is the flow of charge. The charges do not disappear when the circuit is broken, or the "current stops flowing".

- Other types of particles can flow with energy to make electricity, but electrons are what flow in metals.
- Wires aren't empty until they are attached to a source such as a battery. When a battery is connected, electrons move very slowly everywhere at the same time, like a wheel.
- Students may picture robots as friendly metal AI creatures from storybooks, or big machines in factories. It may help to do some quick research and talk about how fixed ideas can limit engineering.
- Engineering involves a lot of creativity and working with other people. There are a variety of engineering jobs and lots of different types of people become engineers. A class discussion on the kinds of engineering and skills all engineers need could be a good addition to the introduction of this lesson plan.

Common Solutions

We see troubleshooting as an exciting learning opportunity to figure out more about how things work. Encourage learners to keep asking questions and trying out ideas to find solutions.

The most common problem is making a solid connection between the parts.

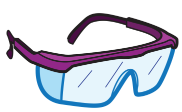
- Make sure the battery is securely connected to the battery snap.
- The parts need to be connected as instructed.
- The alligator clips need to be touching the metal on the wires.
- The alligator clips can be difficult to squeeze to open. Younger students or those students with dexterity and/or fine motor skill issues may require assistance using the alligator clips.
- If the wire is too thin to be held by the alligator clip, the wire can be wrapped around the metal "mouth" of the clip.
- If the end of the wires does not have enough metal wire expose, some of the insulation on the wires may need to first be stripped off so that students can

manipulate the wire. Wire stippers can be used. A dull pair of scissors can also be used to score the plastic insulation and then pulled off with fingers. Young children should not strip wires, only an adult should complete this, if needed.

- Students may come up with other ideas, but one of the most effective ways to make the bot wiggle is to attach a piece of tape or tape a small object around the motor like a flag or propeller blade.
- Another way to encourage the bot to wiggle is to make sure the alligator clip wires and battery clip wires are not dragging on the table. By moving and taping these to the side or top of the bot should help get it to move around.

Review Safety Procedures

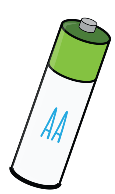
It's important to be aware and cautious when working with electricity or any hands-on project. Please go over the following with participants.



Protect Your Eyes

Watch Out For Others

Use Caution With Tools



Use Parts As Directed

Materials and Tools

The materials for this lesson are available in the Motorized ArtBot Kit at shop.kithub.cc.

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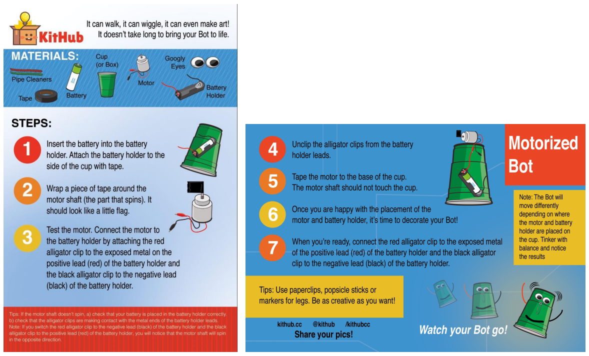
<tr>
<td>
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<td>Motorized ArtBot Instructions

KitHub Education Standards

KitHub's Vocabulary for Learners

KitHub's Vocabulary for Facilitators</td>
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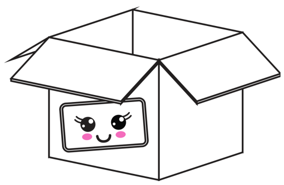
<td></td>
<td>Box (or other container such as a paper cup).

Printable Templates (optional):

Car

Pet (Cat and Dog)

Wind Turbine

Jack-O-Lantern</td>
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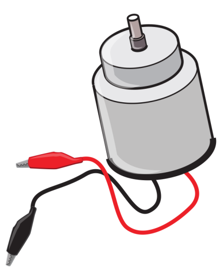
<td></td>
<td>Hobby Motor</td>
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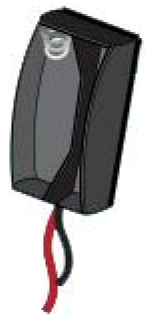
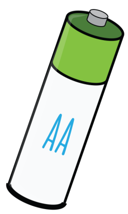
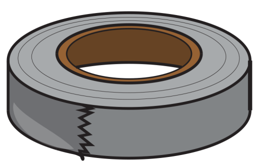
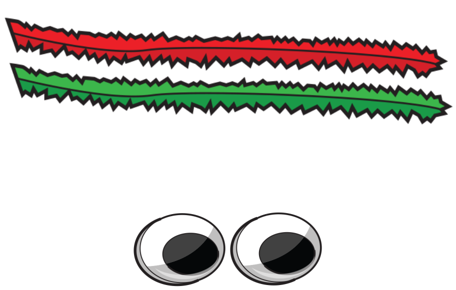
	AA Battery Holder
	AA Battery
	Tape - Clear, Duct, Electrical
	Scissors (not included in the kit)
	Pipe cleaners, googly eyes and other craft materials to decorate the bot.

Learning Outcomes

Science*Engineering*Design*Art*

✓ Complete a circuit using a battery and a motor.

✓ Use the engineering design process to collaborate with a team to design and test a robot.

Standards

The following are learning standards from a range of important national contributors. These can be seen as specific learning outcomes, skills, or performance indicators. Refer to the *KitHub Education Standards for K-8* that cover:

- Common Core State Standards (CCSS)
- International Society for Technology in Education (ISTE)
- National Art Education Association (NAEA)
- Next Generation Science Standards (NGSS)
- New York State Learning Standards (NYSP-12SLS)
- Texas Essential Knowledge and Skills (TEKS)

Lessons

6 Parts, 4 Hours Total

Introductory Activity

30 minutes

Gather Materials

- Begin a class discussion about robot battles. Ask students if they have ever seen these on television or on the internet. If resources are available, show this video about Battlebots found here or here. If resources are not available, show pictures of Battlebots battles or call on student knowledge of the popular engineering pastime. Internet resources and books are provided at the end of this lesson for easy reference.

- Discuss what students notice about the video. Draw students' attention to the engineers and their design process. Now would be a good time to introduce the engineering design process if students are unfamiliar. As each step of the engineering design process is discussed, have students point out examples of that step from the video. If students are familiar with the engineering process, quickly review and discuss prior knowledge and discoveries. It will be helpful to post the design process or have students write it in their science journal.

- Ask students about the process the engineers in the video use to design their robots, then introduce the process they will be working through in this lesson. Have students point out similarities and differences in the process the engineers in the video used compared with the one they will use in this lesson.

- Show and display the materials from the KitHub Classroom Kit. Review the proper techniques for handling and working with each item. Briefly review the parts of a circuit and how simple circuits are built. Remind teams they will need to integrate at least one simple circuit into their robot.

- Explain to students that like the engineers in the video, they too will be working in engineering teams using the engineering design process to create a robot for a BotBot battle. Tell students that they will need to create a BotBot that can attack and defend against another BotBot in battle.

- Students should get in groups of 2-4 to begin the engineering process. There should be an even number of groups for the most effective tournament bracket set up. Have students recall that just like the Battlebot teams, engineers usually collaborate and work together. Once students are in groups, talk through the process of this lesson, expectations for the work and materials, and answer any questions students may have.

Part One

45-60 minutes

- As a team, students should begin researching Battlebot and robot designs in the computer lab or the library. They should take notes in a science notebook of designs they like and ideas they think will work. They should also be sure to cite their sources. Observe student groups as they are completing research. Question students to make sure they are being critical of their resources. A few internet resources have been given

- Once groups feel like they have researched enough ideas, it's time to start the next stage of the engineering design process: brainstorming. As a team, students should diagram and explain at least three different BotBot designs. You may choose to have students use the attached design worksheet.

- While students work, circulate and observe teams at work. Question each team to check for their understanding of their team's work:
    - *Why did you decide to do it this way?*
    - *Which ideas came from your research? How did the research help you decide how to design your BotBot?*
    - *Which stage of the engineering design process are you in right now?*
    - *Why do you think will/won't work?*
    - *Are you sure you have your circuit diagramed correctly? What do you think each part is doing?*
    - *Can you design your robot another way that will still work?*
    - *Which robot design do you think is best? Why?*
    - *Have you thought about adding/subtracting parts?*
    - *What do you think other groups' robots might do that you might need to adjust for?*

Part Two

60-90 minutes

- As groups finish their designs and select their best one, have them share their chosen design with you. Approve each team's design, making sure it meets all of the basic criteria. If any designs are missing an element, send the team back to add the missing element.

- Once students have an approved design, they are ready to move on to building their best design. To keep the battle fair, review the ground rules with the whole class:
    1. Only pre-collected materials and KitHub materials can be used in the robot design.
    2. Designs must use at least one simple circuit.
    3. BotBots must be tested in your group before they can battle another BotBot.
    4. Respect other groups' space.

- Give groups enough time to build, test, and redesign their projects. Begin calling out time left when students have less than 15 minutes.

- Have students step away from their BotBots to join a whole class discussion before the BotBot Battle begins. Discuss any problems and successes that the groups had. Let students lead discussion as much as possible, but guide with questions. Have students predict what will happen in the battle, giving evidence to support their claims.

Part Three

45 minutes

- Explain and discuss the battle structure. It might be best to have students draw numbers for a tournament placement. You can use the Tournament Bracket found in the Resources section, or you can modify it to suit the number of groups in your class.

- Begin BotBot battles. The BotBot that causes the most damage and functions the best during one minute of battle is the winner. This can be determined by a teacher-created rubric or by student vote. Continue until one BotBot has won the tournament.

Part Four

10 minutes

- After a BotBot has been declared the winner, have a discussion about the tournament. Ask students to provide evidence for why they think the winning BotBot won. Point out successful attributes of BotBots that didn't make it. Encourage students to ask questions, share ideas and experiences, and relate new information they learned during the class discussion.

- Go over the engineering design process again. Ask students:
    - *How did the engineering process help your group?*
    - *How did your group's design change after you tested it?*
    - *How would this tournament have gone for your group if everyone else followed this process and your group didn't?*
    - *Is there anything you would change about your BotBot now that the tournament is over? Why?*

- Summarize and elaborate on any misconceptions to finish the lesson.

Part Five - Evaluate

10 minutes

Give students the attached rubric to evaluate themselves, their groups, and their BotBot.

Extensions: Visual Programming

Scratch is a free visual computer programming language available at http://scratch.mit.edu to make your own interactive stories, games, and animations. Scratch helps young people learn to think creatively, reason systematically, and work collaboratively — essential skills for life in the 21st century. Scratch is designed especially for young people ages 8 to 16. ScratchJr, is a simplified app version of Scratch designed for ages 5 to 7.

More coding activities can be found at *Kithub's Coding Activity Guide*.

Activity 1

1. Review Battlebot Games on the Scratch website.
2. Choose one of the games and play it.
3. Make a comment about something that you enjoyed about the game.

Activity 2

1. Remix the Battlebot Game and transform it into a digital version of the Motorized Artbot Battlebot design you made.
2. Have students review each other's games and make comments.

Resources

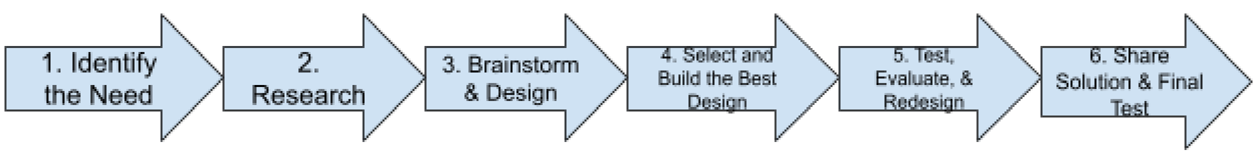
http://battlebots.com/robot/beta/

http://www.tested.com

https://www.wired.com/story/the-terrifying-technological-tactics-behind-battlebots/

Engineering Design Process

This can be drawn and displayed in the learning environment, students can copy it into their notebook, or it can be printed out and given to students.



Cross-Curricular Connections

- Have students create a BotBot museum. They can use already completed and tested Battle Bots, or recreate the bots into robotic sculptures. Students can write titles and background information on each piece, create a guide, and invite other students, teachers, or community members to attend.

- Use the BotBots to design and test a probability model. (CCSS.MATH.7.SP)
- Use a research journal as part of the engineering design process. Compare and contrast sources and information by developing a rubric or hierarchy. Cite evidence in support of a specific design or idea. (CCSS.ELA-LITERACY.RST.6-8.9) (CCSS.ELA.LITERACY.WHST.6-8.9)
- Research scientists and inventors that work(ed) with electricity and robots. Compare and contrast your robot invention process with another scientist.

Literature Connection

We recommend these books. Find more on the KitHub Goodreads account.

Awesome Robotics Projects for Kids: 20 Original STEAM Robots and Circuits to Design and Build (Awesome STEAM Activities for Kids by Bob Katovich

Bots! Robotics Engineering: with Hands-On Makerspace Activities (Build It Yourself) by Kathy Ceceri

Karakuri: How to Make Mechanical Paper Models That Move by Keisuke Saka

The New Way Things Work by David Macaulay

Reinvent the Wheel: Make Classic Inventions, Discover Your Problem-Solving Genius, and Take the Inventor's Challenge by Ruth Kassinger

She's Building a Robot by Mick Liubinskas

Team Moon: How 400,000 People Landed Apollo 11 on the Moon by Catherine Timmesh

The Technology Book for Girls and Other Advanced Beings by Trudee Romanek

What Color Is My World?: The Lost History of African-American Inventors by Kareem Abdul-Jabbar

The Wright Brothers: How They Invented the Airplane by Russell Freedman

Alternate Directions for Independent At-Home Learning

For students in a synchronous class setting where the instructor is providing virtual instruction and learners are at home:

- Option 1: Students can work in break out rooms in the live instructional platform (i.e., Zoom, Google Meet, etc) to design their group's robot. One representative from the group can build the robot to demonstrate to the class.
- Option 2: Each student designs and builds their own robot.

Instead of the robots battling each other, provide a problem that the building of each robot would solve. There could be a class problem to solve or each group/student could be given a unique problem. Each student can use their webcam to show how their robot works, or students can take a video of their robot to share. After seeing how each robot works, class discussion could be held to review which designs were successful.

For students in an asynchronous or homeschool learning environment:

Since the student's robot would not be able to battle another robot, learners can still complete the engineering design process by creating a robot to solve a problem or meet a specific need. Two examples are given below:

- Create a robot that pushes another object
- Create a robot that pulls another object

Evaluate Understanding

We believe the best assessment approach is process-oriented, focusing on creating opportunities for learners to talk about their creations (and peers) and creative practices. We view assessment as something done with learners to support their understanding of what they know and what they still want to know. Use the attached printable self-assessment to have students self-evaluate learning objectives.

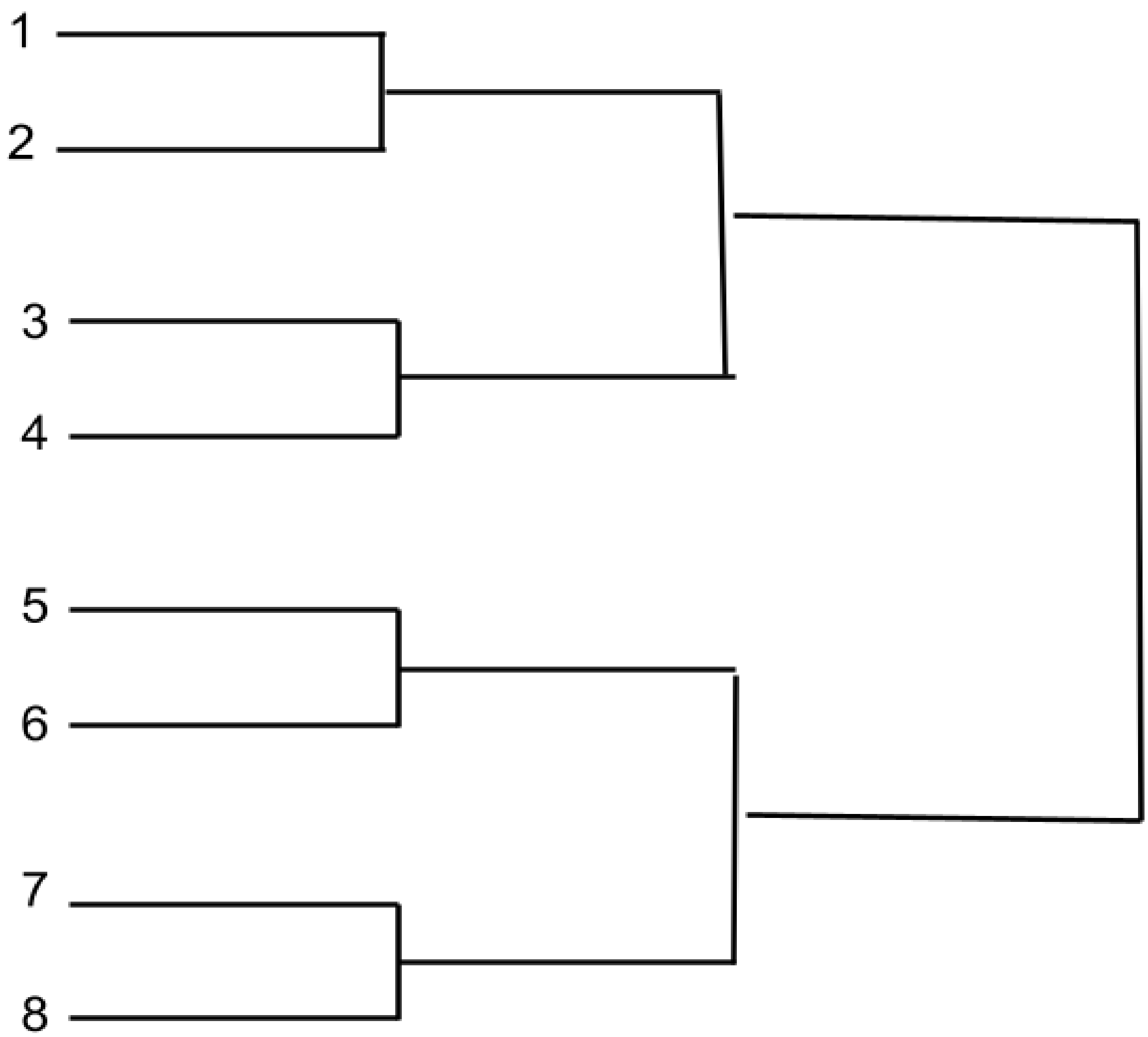
BotBot Battle Designs

Design sketch (label parts)	Research Notes	Design Pros	Design Cons
Design 1			

Design sketch (label parts)	Research Notes	Design Pros	Design Cons
Design 2			
Design sketch (label parts)	Research Notes	Design Pros	Design Cons

Design 3			

Tournament Structure for BotBot Battle



BotBot Battle Evaluation Rubric

	Unsatisfactory (1 points)	Developing (2 points)	Satisfactory (3 points)	Outstanding (4 points)
Teamwork	Did not complete any assigned tasks and relied on others to do all the work.	Did some tasks that may not have been agreed upon. Worked in isolation or did not listen to the group.	Did most assigned tasks and collaborated. Listened to the group, but may have talked too much or too little.	Performed all assigned tasks without having to be managed. Listened to and encouraged the group.
Research	Did not collect and record any research or consulted inappropriate materials for research.	Collected little research, some of which was irrelevant.	Collected and recorded enough research to help design BotBot.	Researched and recorded thoroughly using appropriate materials. Collected research made BotBot design successful.
Engineering Design Process	Ignored the design process.	Followed a few parts of the design process and did not reflect on initial design.	Followed the design process.	Followed the design process and used resources, note taking, and collaboration to reflect on each part.
Participation	Did not participate.	Participated minimally. Group may have complained about you or your participation was generally unhelpful.	Participated in all group work and discussions during the lesson. Generally respectful of classmates.	Was a valuable and respectful member of the team and contributed insightful comments and questions in whole class discussion.
Battle Rank	Did not make it to the battle.	Did not make it past the first round.	Made it to the second round.	Made it to the final round. (Bonus point if you won the final round!)

About

KitHub

KitHub was founded in 2014 in Los Angeles, California, by two women with expertise in hardware and software development, education, and running makerspaces. The company offers hands-on science, technology, and environmental projects that engage and delight the curious mind. Engineers and scientists design our activities, and certified educators write the lessons. Contributors have experience teaching hands-on projects in the classroom, makerspaces, and through distance learning. We provide materials, lesson plans, and assessments so that you're ready to facilitate when you receive your KitHub kit.

Pedagogy

KitHub utilizes project-based learning techniques that include open-ended investigation intended to foster deep inquiry and critical thinking. At the same time, learners work toward producing possible resolutions to authentic challenges. Our lesson plans incorporate the BSCS 5E Instructional Model: Engage, Explore, Explain, Elaborate, Evaluate, and the Connected Learning framework that connects personal interests to meaningful relationships and real-world opportunities. Incorporate the projects into a curriculum, unit, the lesson of the day, or extracurricular activity.

When a learner follows their interests, has support from mentors and peers, and tangible connections to real-world opportunities, it manifests into a thriving space to learn at home and school. Their attention increases, learning deepens, resilience strengthens, and 21st-century competencies expand. Our activities provide repeated exposure to project-based learning processes, so understanding happens through making, not memorizing. Learners will be able to practice the skills and thinking needed for future science, technology, engineering, and math opportunities, utilizing creative and critical thinking skills.

Support

For support, use the chat feature on our homepage, join our Slack channel, or email us. We also have live support sessions that you can find on our calendar.