LESSON PLAN

Quad squad robots

Quad squad robots
A STEAM geometry lesson

OVERVIEW

Along with arithmetic, geometry is one of the oldest branches of mathematics. Essentially the study of shapes (including the space they occupy and the rules around those relationships), geometry is included in maths curriculums around the world for students at most every grade level.

Combining aspects of geometry, the visual arts, technology and problem-solving, this multi-stage STEAM activity centres on quadrilaterals. Students examine quadrilaterals from different perspectives, exploring concepts including patterns, sequence, parallel lines and angles.

START EXPLORING

The first thing to do is introduce (or re-introduce) students to quadrilaterals. Look at the definition of a quadrilateral (a shape with four sides and four angles) as well as the different categories of quadrilaterals (squares, rectangles, rhombuses, parallelograms, trapezoids and kites).

Draw each quadrilateral shape on the board. You may also want to pass out worksheets with all the shapes displayed. It is important to look at all the examples together in order to compare and contrast them. There are many mathematical standards and concepts you can touch on during this overview session depending on your students' grade level and abilities. A few ideas:

- Identify everyday objects shaped like different quadrilaterals.
- Examine how the shapes in different categories (e.g., a kite and a rhombus) share attributes (e.g., both have four sides and four angles).
- Look at the lines in the different shapes. Pay particular attention to line lengths of the different sides (compared to the line lengths of the other sides) and which lines (if any) are parallel in each shape type.
- Categorise the quadrilaterals as regular or irregular shapes.
- Map out the shapes in terms of category hierarchies (e.g., all squares are rectangles, all rectangles are quadrilaterals). Display these relationships in different ways, such as with Venn diagrams.
- Explore how attributes belonging to a category also belong to all subcategories of that category. For example, all quadrilaterals have four angles, so all rectangles and all squares also have four angles. Rectangles have four right angles; therefore, all squares have four right angles.
- Split the quadrilaterals into other common shapes, particularly squares and triangles.
- Identify the angles in the quadrilaterals as greater than, less than or equal to a right angle.
- Use angle properties to identify parallel lines in the quadrilaterals.

MAKE A QUADRILATERAL ROBOT

Break out the construction paper! After examining the different standard categories of quadrilaterals, explain to students that they will be making a robot using only these shapes.

Have students cut out quadrilateral shapes for the different parts of their robot, including the body, head, arms, legs and the various details, like eyes and buttons. Encourage students to use the correct names for each quadrilateral as they assemble their robots. Once they have their robot design created, they can glue down the different quadrilateral cut-outs to create their robot masterpiece.

> **Hint!**
> This portion of the lesson has been adapted from the activity 'Quadrilateral Robots' by Jenny K. For brilliant step-by-step instructions on how to run this part of the activity and other supporting resources for this section, check out 'Quadrilateral Robots' by Jenny K at www.jennyknappenberger.com/quadrilateral-robots/

In addition to the creative fun kids will have designing and creating their robots using only quadrilaterals, this art project is a great way to become really familiar with the properties of all the types of quadrilaterals. The hands-on and visual exposure will give students confidence in tackling the next activity section.

FIND THE LOOPS INSIDE QUADRILATERALS

When we think of loops, we usually envision curves, not corners. In this activity, we aren't talking about curved shapes, however. We are looking at the coding structure known as loops.

In coding and computing, a loop is a special piece of code that tells a computer to repeat something multiple times. Loops are a type of control structure, meaning that loops control other bits of code in a program. Loops let us repeat other bits of code multiple times without having to write each command over and over.

Because quadrilaterals contain repeating patterns, these shapes are a great way to introduce and practice the coding concept of loops while reinforcing geometry concepts, including calculating angles.

GET OUT EDISON

The goal of this activity is to write a program for an Edison robot so that the robot can drive in the shape of a quadrilateral. Students will use the programming language EdScratch for this activity, available at www.edscratchapp.com

> **Hint!**
> Students will get the most out of this activity if they already have a basic understanding of the concept of sequence in coding. If you haven't introduced this concept yet, consider running an unplugged activity with your class first. Two great options can be found in the EdScratch lessons: **U2-1.1a Change it up: Make a PBJ sandwich** and **U2-1.1b Change it up: Human robots**. If students haven't used the EdScratch programming language before, you may also want to run an introduction session based on EdScratch activity **U2-1.2 Let's explore going step-by-step in EdScratch**.

QUADRILATERAL EDISON

Explain that students will be using EdScratch to write programs for an Edison robot. The goal is to get Edison to drive in the shape of some of the different quadrilaterals, the first being a square. While the majority of this activity only requires students use their programming device, to test they will also need the Edison robot, so make sure students are comfortable downloading and running programs with Edison to keep things moving smoothly.

JUST FOR FUN:
EDISON'S QUADRILATERALS

Look at Edison. Can you spot any quadrilaterals?

We sometimes refer to Edison's 'stop' button as the 'square' button. Is Edison's 'stop' button really a square? Is it a quadrilateral?

The first task students should attempt is driving a square. Either use **EdScratch activity sheet U3-1** or create a test space by drawing a square on paper or marking it out on the floor or a desk with coloured tape. Tell students to write a program that will get the Edison robot to drive the square. This time, their program can only use blocks from the 'Drive' category in EdScratch.

Hint!

Students can write programs individually or in pairs. You can then have volunteers program the Edison robot with their code and try it out in the test area for the class to see.

Once students have written and tested their programs, ask what they notice about the programs they created. How many code blocks are in the program? Is there a pattern to the blocks?

Explain that while it is possible to write a program using only 'Drive' code blocks, there is another, more efficient option: the program can be written using a loop control structure. Introduce what loops are and why they are useful.

Hint!

The EdScratch activity **U3-11 Let's explore repeating steps** contains full step-by-step instructions and explanations you can use for this task. You can also use **activity sheet U3-1** for a test space for students to try out their program.

Check students understanding of the concept by getting them to help identify how a loop might be used in the 'drive a square' program. Test their suggested solutions as a class and debug any issues as a group.

The next task is to have students apply their understanding of loops to other shapes. Have students choose a different quadrilateral to drive. Instruct students to make a workspace to test their program by either drawing their quadrilateral on paper or marking it out on the floor or a desk with coloured tape. Then have the students write a program for Edison using EdScratch so that the robot can drive their shape. Remind students to include repeat (loop) block(s) when possible and to try to make their program as efficient as possible, meaning using as few blocks as they can while still completing the task.

TEST IT OUT

Encourage students to use their understanding of quadrilaterals to help them design their programs.

What will all the angles in the shape add up to? How can they use that information to help them determine the degree input for the robot?
What patterns does the shape contain? How can these patterns be translated into loops?

> **Hint!**
> The EdScratch activity **U3-1.2 Let's explore loops and sequence** and the complementary **activity sheet U3-5** contains an irregular quadrilateral. You can have students work through this task instead of making their own shape or as a transition task before they create their own quadrilateral.

Once a group feels confident that their program will work, have them download and test it using the robot.

BONUS CHALLENGE: DOODLE-BOT

Add an engineering build element to this project by getting students to attach a pen to Edison so that the robot can draw a quadrilateral. Have students collaborate to design and then build a way to attach a pen to the robot. They will also need to program the robot to drive in the shape of a quadrilateral of your choosing. Have groups test their design and program to see how accurately their Doodle-bot can reproduce each type of quadrilateral.

SUPPLIES

Required:

- A whiteboard or projector
- Scissors
- Glue
- Construction paper (both for cutting out quadrilaterals and gluing down the finished robots)
- Computers or tablets for programming (1 per student or student group)
- 1 Edison robot
- Test area supplies (activity sheets or supplies to make the test quadrilaterals)

> **Got more than 1 Edison robot? Perfect!**
> Have each student or group work with their own robot when working through the 'loops in quadrilaterals' tasks. You can still have students partner up for pair programming, which is a great way to encourage students to talk through their thought processes. Groups can also trade quadrilaterals with other groups once they have successfully completed their shape. This gives students more chances to write programs for their robots to drive different shapes, seeing how each shape type changes the possibilities of using loops. The Doodle-bot challenge will be much easier to attempt with multiple robots as well. Allowing each group to have a robot for the entire challenge will enable them more opportunities to work through the engineering design process, testing and iterating their creation.

Recommended:

- Handouts of quadrilateral shapes
- EdScratch lesson and activity sheets:
  - U3-1.1 Let's explore repeating steps plus activity sheet U3-1
  - U3-1.2 Let's explore loops and sequence plus activity sheet U3-5

Optional:

- EdCreate kits/LEGO bricks and/or any other maker space materials (for the Doodle-bot challenge)
- EdScratch lessons:
  - U2-1.1a Change it up: Make a PBJ sandwich or U2-1.1b Change it up: Human robots
  - U2-1.2 Let's explore going step-by-step in EdScratch
  - U3-1.1f Challenge up: Doodle-bot challenge