# LESSON 8: SPIRALING SQUARE

## Overview:

Students will use the DroneBlocks program to fly their aircraft in a “spiraling square” pattern. This lesson will build on the navigational skills presented in the previous lessons and will reinforce the loop and variable concepts introduced in the prior missions. Introductory and extension lesson ideas are included to provide opportunities for students to research, integrate subjects and add depth to their learning.

Figure 8.1

## Objective:

Students will:

- Discover and research spirals in the world around them
- Calculate and determine program blocks for altitude, distance, and yaw
- Run a test-flight of the program through a Preview Mission
- Launch a field mission that will take their drone in a spiraling square flight path.
- Have the opportunity to modify calculations to change the direction and shape of the spiral

## Common Core State Standards:

*Common Core Standards provided focus on grades 5 and 6, as a baseline. Educators should adjust standards based on the ability and/or experience of their students.*

CCSS.MATH.CONTENT.5.G.B.3: Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.

CCSS.MATH.CONTENT.5.OA.A.2: Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them.

CCSS.ELA-LITERACY.W.5.7: Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

CCSS.ELA-LITERACY.RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-LITERACY.RST.6-8.2: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

CCSS.ELA-LITERACY.RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

CCSS.ELA-LITERACY.RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

CCSS.MATH.CONTENT.6.EE.A.1: Write and evaluate numerical expressions involving whole-number exponents.

CCSS.MATH.CONTENT.6.G.A.1: Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.

CCSS.MATH.CONTENT.6.G.A.3: Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.

## International Society for Technology in Education Standards:

ISTE 1.a Apply existing knowledge to generate new ideas, products, or processes

ISTE 1.b Create original works as a means of personal or group expression

ISTE 1.c Use models and simulations to explore complex systems and issues
ISTE 2.a Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media

ISTE 2.b Communicate information and ideas effectively to multiple audiences using a variety of media and formats

ISTE 2.d Contribute to project teams to produce original work or solve problems

ISTE 3.a Plan strategies to guide inquiry

ISTE 3.b Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media

ISTE 3.c Evaluate and select information sources and digital tools based on the appropriateness to specific tasks

ISTE 3.d Process data and report results

ISTE 4.a Identify and define authentic problems and significant questions for investigation

ISTE 4.b Plan and manage activities to develop a solution or complete a project

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## Materials Needed:

- Art Supplies (If planning to add the art component while introducing spirals)
  - Paper
  - Drafting Compass
  - Triangle Ruler
  - Pencil
- Access to Internet for research
- Pre-Flight Checklist
- DroneBlocks App Downloaded on iOS devices for students
- Drone
- Propeller Guards

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## Part 1: Spirals Around Us

### Researching Spirals

Spirals are everywhere. They can be found on our bodies, in the air, and in the environments in which we live. This lesson is compelling because it opens students' eyes to how often spirals are found in nature, architecture, math, science and art.

First, ask your students to brainstorm as many different types of spirals they can think of. Initially, get them brainstorming without the Internet. Think: fingerprints, Slinkys, tornadoes, the curvature of spacetime, shells, ancient symbolism, mechanical springs, the helix, antelope horns, the law of generating matter… Acknowledge to your students that some spirals are more precise than others. Why is this?

Next, challenge your students with a research activity. Ask students to choose one type of spiral, research the design (even if it is derived from nature) and speculate:

> Why is this a spiral? Is the cause for this spiral have mathematical or scientific reasoning?

Did you know? The Einstein Spiral is a series of right triangles that forms a spiral shape. The hypotenuse of each triangle equals an increasing square root number. This spiral is also known as other names. What are they and why do you think there are multiple names for the same geometric spiral?

Throughout this lesson, student answers will be significant and vary greatly. Do not allow them to conclude that any spiral happened or was designed only by chance. Remind them that even fingerprints are friction ridges formed in the womb and there are theories that fingerprints can be mathematically predicted.

Depending on the amount of time you have allotted for this lesson and the standards in which you plan to apply, give students parameters as to how you would like them to present their research. Should they plan to present to the class, prepare a presentation, or write a composition? Be forewarned, this activity can be fascinating. You could just possibly spend an entire week researching the spirals and patterns in fingerprints alone!

Encourage students to reach out globally to learn more about their spiral. Participate in a Skype session, Google Hangout, or post student work on your class Twitter feed. When learning goes beyond the classroom, your students' learning will have greater value with the opportunity to share!

**Educator Note:** As with all online research, remind your students of digital citizenship. Excellent resources have been provided in previous DroneBlocks lessons. Consistently revisit digital citizenship and remind your students how to properly cite resources and graphics. Google makes it simple for students to cite resources. Apps and extensions such as Easybib are also fantastic tools for citing sources.

### Transform your STEM lesson to STEAM by adding Art:

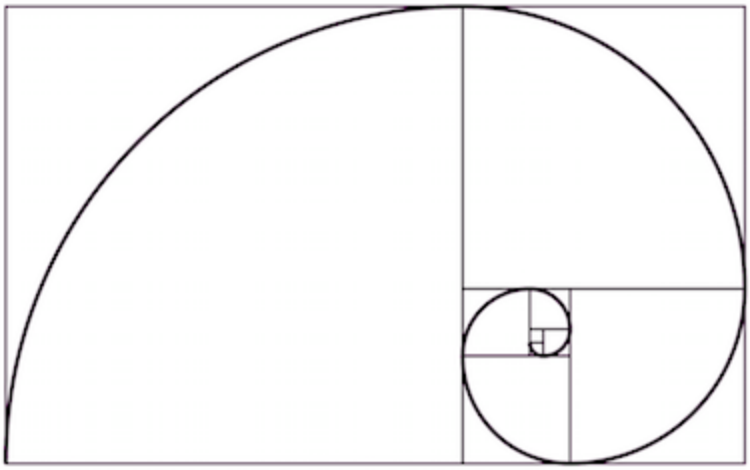


Figure 8.2

Draw a Fibonacci Spiral (or Golden Spiral), as shown in **Figure 8.2**. Depending on the age and skill of your students, ask them to research then draw a Fibonacci Spiral! Require students to calculate their drawings by figuring the sizes and distances of the squares and angles they used. If you're not sure how to do this yourself…participate and learn alongside your students!

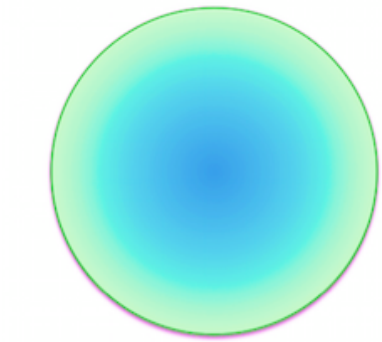
For resources, there are many samples and videos available.

"How to draw the Fibonacci Sequence / Golden Spiral - Step by Step Tutorial (English)" by seinSelbstsein.de is a great video because it provides measurements and provides a fantastic tutorial of this incredible logarithmic spiral and progresses at a gradual pace. This instructional video is definitely a favorite of DroneBlocks.

Once the spirals are drawn and perimeter, area, squares, angles, distances, etc., are calculated, allow your students to get creative! Use recycled materials, yarn and glue, paint, crayons, or anything in your MakerSpace to turn these mathematical drawings into works of art! If your students have access to digital creating games, drawing programs, or coding programs, have them recreate their spirals digitally.

**Figure 8.3** shows digital student examples:


Minecraft



Adobe Illustrator

Scratch.mit.edu

Figure 8.3

Did you know? The difference between STEM and STEAM education is the addition of art in the latter. At DroneBlocks, we believe that art can always be incorporated into our lessons and is a key way to personalize learning, especially when sharing what has been learned, designing missions or using a drone for photography. There is an ongoing debate about whether the arts belong in STEM education. What do you and your students think?

## Part 2: Mission Plan

As previously mentioned, this mission is called "Spiraling Square" and students will program the aircraft to fly in a square shape that spirals outward around the flying area. Each leg of the flight increases in length, as programmed, using variable blocks. Remember: a **variable** is a value that can change, depending on conditions or on information passed to the program.

The overall concept of this mission is to program a set of commands that instructs the drone to take off and navigate in a pattern similar to **Figure 8.1** above.

Key components of the Spiral Square:

- Takeoff to altitude (recommend 50 feet or a height that is clear of nearby obstacles)
- Fly in 12 legs
    - o Fly in a clockwise direction
    - o Turn 90 degrees at the end of each leg before flying the next leg
    - o Each leg should be 10 feet longer than the previous leg.
- Land

**Figure 8.4** is one example of the how the spiral square mission can be programmed:

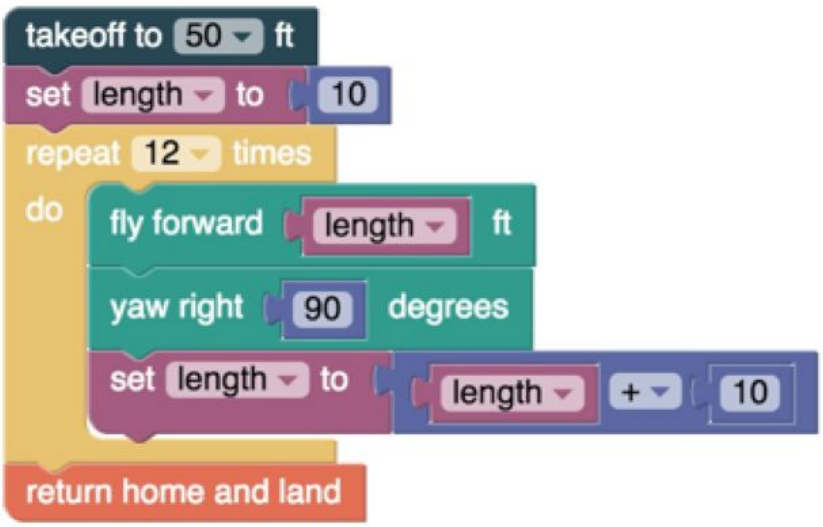



**Figure 8.4**

For additional information regarding variable and loop blocks, read this DroneBlocks blog post.

Students may individually program this mission on their own or in teams. Let your students explain their missions and run them in "Preview Mission". When programming, you may forget a simple instruction. Seeing the code run on the preview is a clear indicator of what needs to be fixed.

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## Part 3: Calculating the Flight Area

Unlike prior missions, where it was easy to calculate how much space the missions will take, this one is a bit more complicated. Work with your students to plan out how much area you'll need for this mission.

You may choose to revisit DroneBlocks "**Lesson 1: Safety**" to be reminded of safe flying distances. Walk or measure the area in which you plan to fly.

Be certain you have programmed your mission within safe flying distances.

Students may individually program this mission on their own or in teams. Let your students explain their missions and run them in "Preview Mission".

REMEMBER:

- When running preview missions indoors, the aircraft and remote should be powered off.
- Never let the students connect to the aircraft indoors, as they could accidentally activate the mission, resulting in an extremely dangerous indoor flight.

Previewing missions allows you to see if your mission is programmed correctly. When programming you may forget a simple instruction. Seeing the code run on the preview simulator is a clear indicator of what needs to be fixed.

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## Part 4: Field Mission

Now that the mission has been reviewed by the teacher and run in the mission preview, it is time to take the program to the field. Most of the hard work has already been done and now it is time to enjoy the rewards of programming and testing. Before running the mission in the field make sure to review the safety steps as you have done previously. These steps will apply to every field mission.

IMPORTANT:

- Take a copy of the Pre-Flight Checklist to the flying area, and complete every step of the pre-flight checklist before running the mission.
- As the Phantom 3 is flying, always be prepared to manually take control of the aircraft if it behaves unexpectedly by switching back to P-mode. If operating a Phantom 4, manually resume control by switching to S-mode. Click here for a video discussing flight modes.
- Note: As tempting as it may be to take a photo directly beneath your drone, don't ever do this. You should not operate a drone above or within 25 feet of people under any circumstances.

Previewing missions allows you to see if your mission is programmed correctly. When programming you may forget a simple instruction. Seeing the code run on the preview simulator is a clear indicator of what needs to be fixed.

With this particular mission, choosing your launch point will be CRITICAL.
Orient your drone AWAY from the group so that it does not fly over students.
Be sure you have sufficient space along the flight path.

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## Part 5: Extensions

As the first extension challenge for this mission, start at the outside of the spiral square and spiral into the center. Re-program the length of each leg to command your drone to travel from the outside of the spiral.

If you are ready for an additional challenge, ask your students to build a "Pyramid" mission! This mission should start on the outside of the spiral and rise in 10' increments as it commands the drone to spiral inward.

Once your students are true masters of the spiral mission, assign a circular spiral mission. What blocks and angles must your students utilize to make the aircraft travel in [what will appear to be] a circular motion, rather than linear lines with visible angles?

Please share your missions, photographs, and thoughts with us on social media @DroneBlocks, especially as you program the extension missions. We are always excited to learn about what you create and how you use DroneBlocks to enrich your learning!

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## Additional Resources

Would you like to learn more about spirals?

Start by visiting these websites:

http://www.demonstrations.wolfram.com/GoldenSpiral/

http://mathworld.wolfram.com/PrimeSpiral.html

https://www.reddit.com/r/dailyprogrammer/comments/3ggli3/20150810_challenge_227_easy_square_spirals/

http://www.naturalnumbers.org/sparticle.html

http://www.placestoseeinyourlifetime.com/top-10-spiral-architecture-9941/

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