# Teacher's & Workshop Guide: Ring 5 - The Navigator (Shapes)

## Polya Studio Discovery Series

### Introduction to the Workshop

Welcome to Ring 5 of the Polya Studio. In previous rings, students dealt with numbers, time, and chance. Ring 5 introduces **Space**. This is the world of Geometry, Navigation, and Optimization.

Your role as the Guide is to challenge their "Straight Line Instinct." Most students know that the shortest distance between two points is a straight line. But in the real world (and in engineering), there are obstacles. You cannot walk through a wall or fly through a mountain.

The goal of Ring 5 is for students to discover **The Tangent Line**. They will learn that when you cannot go *through* an obstacle, the most efficient path is to graze the very edge of it. They will use the "Tangent Triangle" to optimize their path.

### Part 1: The Station Setup

You must prepare a physical environment where the direct path is blocked. You will need a navigation grid.

First, set up a **"Field of Play."** A large sheet of graph paper or a tiled floor works well. Mark a starting point (**Point A**) and an ending point (**Point B**) at opposite corners.

Second, place a **"No-Go Zone"** directly in the center. Use a large red circular object (like a hula hoop or a red paper circle) that blocks the straight line between A and B. Label it **"LAVA PIT."**

Third, provide a **"Rover"** and **"Fuel."** Give the team a small toy robot or car. Give them a piece of string that represents their fuel. The string should be *just barely* long enough to reach Point B if they take the perfect path, but too short if they go wide.

When the students arrive, the challenge is simple: Get the Rover from A to B without touching the Lava, using only the fuel (string) you have.

### Part 2: The Workshop Dialogue

Stand back. Hand them the Rover and the String. Watch them struggle with the "safe" path versus the "efficient" path.

| **Teacher's Nudge (The Guide)** | **Student's Action (The Discovery)** | | "Here is your Rover. You need to get from A to B. But the Red Circle is Lava—if you touch the red, you melt. Also, you only have this much fuel (string). Good luck." | The team looks at the setup. Their instinct is usually fear. They want to stay far away from the "Lava." | | "Test your path." | They lay the string out in a wide arc, giving the Lava plenty of room. **The Friction Point.** The string is too short! It doesn't reach Point B because they

wasted "fuel" going too wide. | | "You ran out of fuel. You went too far around. How can you shorten the path without dying?" | They pull the string tighter. "We need to get closer to the Lava." | | "How close can you get? What is the limit?" | They nudge the string closer and closer until it barely touches the edge of the red circle. | | "Stop. Look at that line. It doesn't cut inside, but it doesn't waste space outside. Draw the Problem." (Hand them the whiteboard.) | The team stops adjusting the string. They move to the whiteboard to sketch the geometry. | | "Draw the Tangent Triangle. Draw the Start, the Finish, and the Edge of the Obstacle." | **The Visualization.** They draw Point A and Point B. They draw the Circle. They realize the perfect line is straight from A to the *edge* of the circle, then follows the curve for a second, then straight to B. | | "This is called a Tangent. It touches the curve at exactly one point. It is the most efficient way to pass a circle." | **The Resolution.** They return to the floor. They pull the string tight so it forms a straight line that "kisses" the edge of the hula hoop. | | "Does the fuel reach now?" | Yes. By using the Tangent path, the string reaches Point B with zero slack. They have optimized the route. |

**Part 3: The Visual Rule (The Tangent Triangle)**

Once they have successfully navigated the course, gather them around the whiteboard. Draw the Tangent Triangle diagram. This is the tool they will use for navigation and efficiency.

The top point of the triangle is **THE OBSTACLE** (The Circle).

- *What is in my way? (The Lava)*

The bottom left point of the triangle is **THE APPROACH** (The Tangent).

- *The straight line that aims for the very edge, not the center.*

The bottom right point of the triangle is **THE GOAL** (Point B).

- *Where am I going?*

**The Rule:** Do not fear the obstacle. Do not go wide. To save fuel (energy), you must get as close to the danger as possible without touching it. Aim for the Tangent.

**Part 4: Teacher's Quiz (Pedagogy Check)**

**Question 1** Why do we give them a string that is "just barely" long enough? A) To frustrate them. B) To force them to find the most efficient path. If the string were long, they would settle for a lazy, wide path. *Correct Answer: B*

**Question 2** What is the "Friction Point" in this workshop? A) When the robot breaks. B) When they try to go wide around the lava and realize the string (fuel) isn't long enough. *Correct Answer: B*

**Question 3** What is a "Tangent"? A) A line that goes through the center of a circle. B) A line that touches a curve at exactly one point without crossing it. *Correct Answer: B*

**Part 5: Student's Quiz (Concept Check)**

**Question 1** You are flying a plane. There is a storm (circle) in your way. To save gas, should you: A) Fly a huge circle around it to be super safe? B) Fly a path that grazes the edge of the storm (Tangent) to

keep the line as straight as possible? *Correct Answer: B*

**Question 2** Why did the "Wide Path" fail? A) It used too much distance (fuel). B) It was too scary. *Correct Answer: A*

**Question 3** What is the Superpower of Ring 5? A) Teleportation. B) Navigation & Optimization (finding the best path). *Correct Answer: B*

**Closing Note**

By the end of this session, your students have practiced **Optimization**. They learned that "Safety" doesn't mean staying miles away from danger; it means calculating the precise line that respects the danger without wasting resources. They moved from being "Wanderers" to "Navigators."