# Teacher's & Workshop Guide: Ring 3 - The Timing Expert

## Polya Studio Discovery Series

### Introduction to the Workshop

Welcome to Ring 3 of the Polya Studio. In the previous rings, students dealt with static numbers and fixed budgets. Ring 3 introduces a new, dynamic element: **Time**. This is the foundation of Calculus, but we teach it as "The Science of Motion."

Your role as the Guide is to challenge their "Linear Instinct." Most children (and adults) naturally think that things move at a constant speed. They assume that if a car travels 1 foot in the first second, it will travel exactly 1 more foot in the next second.

The goal of Ring 3 is for students to discover **Acceleration** and **Rate of Change**. They will learn that speed is not always a straight line; it curves. They will use the "Delta Triangle" to measure how things change over time.

### Part 1: The Station Setup

You must prepare a physical environment that proves "Linear Thinking" is wrong. You will need a simple ramp setup.

First, set up a **"Gravity Ramp."** Use a long, smooth board or a piece of cardboard propped up on a stack of books at one end. The slope should be gentle but steep enough for a ball or toy car to roll down smoothly.

Second, provide a **"Metronome"** or a steady beat. You can use a free phone app that clicks every second, or simply have a student clap at a steady rhythm (one-Mississippi, two-Mississippi).

Third, provide **"Prediction Tape."** Give the students a roll of masking tape or painter's tape.

When the students arrive, the challenge is simple: They must predict where the ball will be after 1 second, 2 seconds, and 3 seconds.

### Part 2: The Workshop Dialogue

Stand back and hand them the tape. Do not explain gravity or physics. Let their intuition guide their initial (incorrect) prediction, and then let the ramp reveal the truth.

| Teacher's Nudge (The Guide) | Student's Action (The Discovery) |
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| "Here is the ramp and the ball. I want you to mark with tape where the ball will be after exactly 1 second, 2 seconds, and 3 seconds." | The team will look at the ramp. Their "Linear Instinct" will take over. They will likely place the tape marks at equal distances (e.g., 1 foot, 2 feet, 3 feet) because they assume the speed is constant. |
| "Lock in your prediction. Now, run the test. One person drops the ball, one person claps the seconds. Watch the marks." | **The Friction Point.** They run the test. The ball rolls past the first mark, but by the second clap, it has zoomed way past their second mark. By the third clap, it is off the ramp entirely. Their prediction fails. |
| "What happened? Did the ball follow your tape marks?" | They look confused. "No, it went too fast at the end." "It missed the marks." |
| "Did the ball move the same distance every second?" | They shake their heads. "No, it covered more ground in the last second than the first second." |
| "So, the speed changed. Don't guess. Draw the Problem." (Hand them the whiteboard.) | The team stops rolling the ball. They move to the whiteboard to visualize the motion. |
| "Draw the Delta Triangle. Draw Where it Started, Where it Ended, and How Long it took." | **The Visualization.** They draw a ramp. They verify that the distance in Second 1 was short, but the distance in Second 2 was long. They realize the distance is growing, not staying the same. |
| "This is called Acceleration. The rate of change is changing. How do we fix the tape marks?" | **The Resolution.** They return to the ramp. They realize they must space the tape marks further apart as they go down the ramp (e.g., 1 inch, 4 inches, 9 inches). |
| "Test your new theory." | They adjust the tape. They run the ball again. This time, the ball crosses the marks exactly at the claps. They have successfully mapped the curve of acceleration. |

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

Once they have successfully spaced the tape marks to match the accelerating ball, gather them around the whiteboard. Draw the Delta Triangle diagram. This is the tool they will use to understand change.

The top point of the triangle is **DELTA DISTANCE**.

- *How far did I go in this specific step?*

The bottom left point of the triangle is **DELTA TIME**.

- *How long did this specific step take?*

The bottom right point of the triangle is **THE SPEED**.

- *The Result: If the Distance gets bigger but the Time stays the same, the Speed is increasing.*

**The Rule:** Nature rarely moves in a straight line. Always check if the "Delta" (the change) is growing or staying the same. If the Delta is growing, you are accelerating.

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

**Question 1** Why do students usually place the tape marks at equal distances? A) Because they are bad at measuring. B) Because the human brain naturally defaults to "Linear Thinking" (constant speed). *Correct Answer: B*

**Question 2** What is the "Friction Point" in this workshop? A) When the ball rolls off the table. B) When the ball zooms past their predicted tape marks, proving their linear guess wrong. *Correct Answer: B*

**Question 3** What does the "Delta Triangle" measure? A) The total height of the ramp. B) The change in distance over a specific step of time. *Correct Answer: B*

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

**Question 1** If you are rolling down a hill, do you cover the same amount of ground in the first second as you do in the last second? A) Yes, speed is always the same. B) No, you go further in the last second because you are speeding up. *Correct Answer: B*

**Question 2** You are tracking a plant's growth. Week 1 it grows 1 inch. Week 2 it grows 2 inches. Week 3 it grows 4 inches. Is this Linear Growth or Accelerated Growth? A) Linear Growth. B) Accelerated Growth. *Correct Answer: B*

**Question 3** What is the Superpower of Ring 3? A) Being able to run fast. B) Understanding how things change speed over time (Timing). *Correct Answer: B*

**Closing Note**

By the end of this session, your students have practiced **Timing**. They learned that the world is