You Can Do the Cube!

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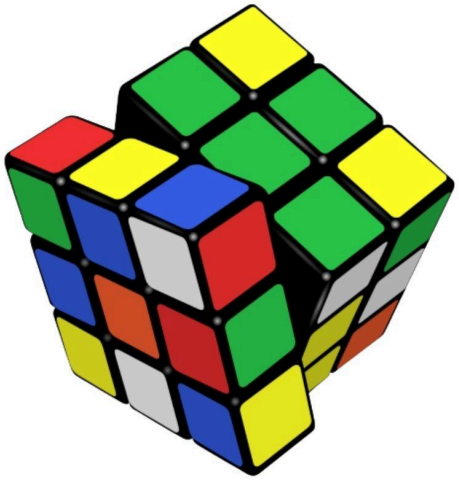
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Goals & Objectives



Goals

- **Mathematical & Logical Reasoning**
  Engage students in hands-on problem solving to cultivate spatial awareness, algorithmic thinking, and pattern recognition.

- **Emotional Resilience & Growth Mindset**
  Foster perseverance by guiding students through complex, multi-step challenges and helping them navigate initial frustration.

- **Peer Collaboration & Community**
  Establish a supportive classroom environment where students transition from individual learners to peer coaches.

Objectives

By completing this workshop, participants will be able to:

1. **Apply the Solving Framework**
   Execute a step-by-step methodology to solve the Rubik's Cube, progressing systematically from basic edge alignment to full layer completion.

2. **Implement Classroom Strategies**
   Utilize actionable, low-cost strategies to introduce high-engagement puzzle mechanics into existing curricula, after-school programs, or STEM clubs.

3. **Facilitate Student Coaching**
   Guide students through self-paced learning pathways that build self-efficacy and transform problem-solving frustration into a celebrated accomplishment.

Florida Standards

Mathematical Thinking and Reasoning (MTR) Standards

- **MA.K12.MTR.1.1**
  Actively participate in effortful learning both individually and collectively.
  Students break down the complex task of an unsolved cube into manageable layers, asking clarifying questions and relying on peer collaboration to push through the "struggle zone."

- **MA.K12.MTR.3.1**
  Complete tasks with mathematical fluency
  Students practice executing multi-step procedures with accuracy. As they move from checking a guide to relying on memory, they adapt procedures fluidly based on the orientation of the cube.

- **MA.K12.MTR.5.1**
  Use patterns and structure to help understand and connect mathematical concepts.
  The core of solving the cube is pattern recognition. Students must analyze the spatial structure of the cube, identify geometric similarities, and execute algorithmic plans to logically order their steps.

Grades 9-12 Algebraic Reasoning Benchmarks (Algebra 1 Focus)

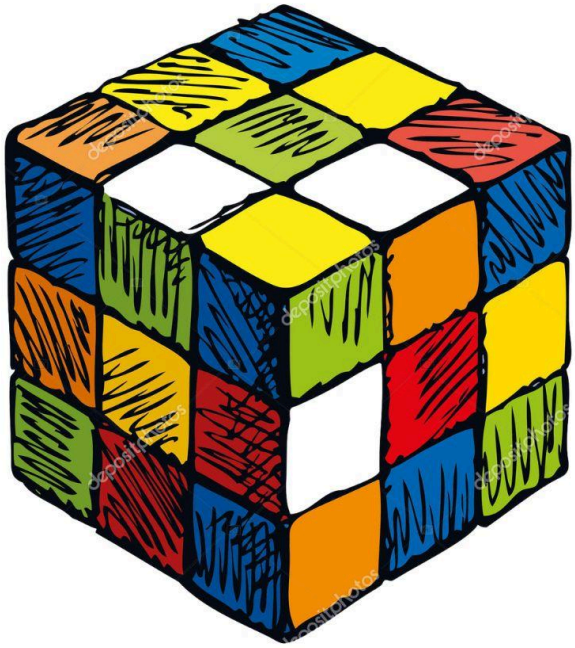
- **MA.912.AR.1**
  Apply algebraic reasoning to expressions and equations.
  While students aren't solving for x on paper, they are applying the fundamental logic of algorithms. They learn that mathematical operations must follow a strict, logical sequence where one step directly influences the next.

- **MA.912.AR.1.1**
  Identify and interpret parts of an equation or expression.
  Students learn to identify, interpret, and manipulate the individual components of an algebraic string (the Rubik's notation language like R, U, L', F_2). They

must understand how each independent "term" or movement affects the expression of the whole puzzle.

- **MA.912.F.1**
  Key Features and Representations
  Students learn to translate abstract, 2D representations (the visual diagrams and notation language in the slide deck and solution guide) into physical, 3D transformations on a real-world object.

  - **MA.912.F.1.1**
    Given a relation, determine whether it is a function
    Solving the cube relies entirely on the concept of input and output. Students learn that a specific algorithmic sequence (the input relation) will consistently produce a single, predictable geometric layout on the cube (the output), which is the foundational logic of mathematical functions.



Overview

Project Rationale



Discover how to transform a classic puzzle into a powerful project that builds mathematical grit, masters algorithmic thinking, and gives every student the ultimate confidence-boosting flex.
In this project, students utilize the Rubik's Cube to develop logic and pattern recognition while fostering the deep resilience needed to conquer complex, multi-step challenges.

The real value of this project is how it changes a student's attitude toward a challenge. Visually, the Rubik’s Cube naturally sharpens math logic, spatial skills, and pattern recognition. But emotionally, it teaches true grit. It is a tough puzzle, and while it presents a genuine hurdle, that is where the magic happens: students learn to handle frustration, and those who catch on quickly naturally step up to coach their peers, building a strong classroom community.

Workshop Approach

This is a hands-on, train-the-trainer model. Teachers do not need prior experience solving a cube to implement this curriculum. Through a step-by-step framework that takes learners from absolute beginners to successful solvers, this high-energy, self-paced activity can be seamlessly introduced into any classroom, club, or educational setting to help students turn frustration into a celebrated success.

Lesson Plans

Target Audience & Flexibility

This curriculum is designed primarily for secondary education (grades 6–12), but can easily be adapted for gifted elementary students.

While the detailed daily guides below are mapped out for a 5-day unit (60 minutes per day), this timeline is completely flexible. Depending on your students' familiarity, pacing, and available period lengths, this project can be condensed into 3 days or expanded across 7 days. Use the phases below as a flexible roadmap for your classroom.

Curriculum Origin & Adaptation

The foundational steps and algorithms used in this curriculum are derived directly from the official Rubik's Solution Guide (www.rubiks.com/solution-guides). That official guide is no secret, but at 40+ pages long, it can easily overwhelm students. Let's face it, most kids aren't going to read through a massive manual.

To solve this, that entire guide has been streamlined down into a 10-slide deck (tinyurl.com/rubikscubeslides). All of the heavy introductory concepts and anatomy are taught live via direct whole-group instruction, leaving the slide deck as a clean, quick visual cheat-sheet focused strictly on the core algorithms students need while working at their own pace.

Phases of Solving

Phase 1: Decoding the Language of the Cube (Days 1-2)

- What Students Do: Learn the anatomy of the cube (centers, edges, corners) and decode notation language (U for Up, R for Right, etc.). They practice basic, single-layer movements.

- What They Learn: Precision, technical reading, and spatial awareness as they map 2D written instructions onto a 3D moving object.

Phase 2: Navigating the Struggle Zone (Days 2–3)

- What Students Do: Work through step-by-step algorithms to solve the first two layers. This is where they hit roadblocks, accidentally scramble their progress, and have to restart.

- What They Learn: Frustration tolerance and pattern recognition. They learn to view mistakes not as failures, but as visual data points that tell them exactly which step went wrong.

Phase 3: Breakthrough (Days 4–7)

- What Students Do: Memorize and execute the final algorithms to complete the cube. Once they cross the finish line, they experience the incredible rush of success, proving they can conquer a complex challenge. Fast-finishers naturally step into the role of peer coaches, guiding classmates without touching their cubes.

- What They Learn: A massive boost in academic confidence and collective celebration. They learn the value of peer-to-peer leadership, discovering how to translate their own breakthrough into supportive encouragement for a classmate.

Lesson 1: Anatomy of the Cube & The White Cross (Edges)

Lesson Focus: Cube anatomy, rotation movements, directional notation, and solving the 4 White Edges without the Daisy.

- **Duration: 60 Minutes**
- **Materials Needed: 3x3 Rubik's Cubes, Streamlined Slide Deck (tinyurl.com/rubikscubeslides)**

1. Direct Instruction / Whole Group (20 Mins)

Part A: Anatomy of the Cube

- **Centers (6):** Fixed in place; they never move relative to each other and define the color of each face.
- **Edges (12):** Pieces with **2 colors** located between center pieces.
- **Corners (8):** Pieces with **3 colors** located on the outer corners.

Part B: 3 Types of Face Rotations

To help students visualize movements without getting tangled in abstract mechanics, introduce these three everyday analogies:

1. **The Ferris Wheel (Right & Left Faces - R / L):** Turning the side faces forward or backward, like a vertical Ferris wheel spinning around its axle.

2. **The Doorknob (Front & Back Faces - F / B):** Turning the front face clockwise or counterclockwise, like twisting a round doorknob on a door.

3. **Opening / Closing a Jar Lid (Top & Bottom Faces - U / D):** Turning the horizontal top or bottom layers, like twisting a jar lid open (counterclockwise) or tight/closed (clockwise).

Part C: Directional Logic (Clockwise vs. Counterclockwise)

- **Standard Move (R, U, F):** Always means turning that face **clockwise**, as if you were looking directly at that specific face like a wall clock.

- **Prime Move (R', U', F'):** Indicated with an apostrophe (read as *"Prime"*), meaning turn that face **counterclockwise**.

Part D: Solving White Edges — "Ground Floor" Strategy (No-Daisy Method):

*Explain to students that the Top (White) and Middle layers are "locked" once a piece is set. The only layer completely free to spin without ruining progress is the **Bottom Layer**.*

1.Take it to the Ground: Locate a White edge piece you are attempting to place correctly and move the target White edge down to the bottom layer ("the ground floor").

2. Walk Around the Building: Spin the bottom layer (like opening/closing a jar lid) until the edge piece's non-white secondary color matches its corresponding Center face color, making the piece have to "walk around the building" to the side it wants to be on.

3. Come Up the Stairs: Execute a 180° "Ferris Wheel" turn on that matching side face to bring the White edge up to the top layer right next to the White Center. Essentially the piece could not just go where it needed to be in the top layer, it had to take the long route there.

2. Guided Practice & Independent Work (30 Mins)

- Students work independently or in pairs to locate all 4 white edge pieces and position them using the "Building & Stairs" methodology.

- Teacher circulates around the room to assist students struggling with spatial rotation or accidentally turning the middle/top layers and verify that students are matching secondary colors with center pieces before bringing edges "up the stairs."

3. Reflection & Resilience Wrap-Up (10 Mins)

- **Debrief:** Ask: *"Which rotation felt the most natural—the Ferris Wheel, the Doorknob, or the Jar Lid?*

- **Discuss** the "Struggle Zone." Ask: *"Did anyone accidentally knock out an edge they already solved? How did you fix it?*

- **Resilience Anchor:** Highlight that making mistakes when positioning pieces is not "messing up"—it provides visual data on which layer moved incorrectly. Remind students that accidental scrambles during Day 1 are normal; every reset is just practice for building speed and spatial awareness.

Lesson 2: White Corners
Finishing the First Layer

Lesson Focus: Corner piece identification, target positioning, and inserting the 4 White Corners.

- **Duration:** 60 Minutes
- **Materials Needed:** 3x3 Rubik's Cubes, Streamlined Slide Deck (tinyurl.com/rubikscubeslides)

1. Direct Instruction / Whole Group (20 Mins)

- **Locating Corners:** Demonstrate how to locate a white corner piece and check all **3 of its colors** (e.g., White-Red-Blue).
- **Positioning below the Target:** Show students how to place the target corner directly underneath the corner slot where it belongs on the top layer.
- **The Corner Algorithm (Right/Left Hand Triggers):** Demonstrate the short, repeating 4-move algorithmic trigger (R' D' R D) used to slot the corner into place without disrupting the White Cross.

2. Guided Practice & Independent Work (30 Mins)

- Students work to complete all 4 corners of the White Layer.
- Early finishers who complete the full White face (with matching side-layer T-shapes) step into the role of **Peer Coaches** (coaching with words only—no touching other students' cubes!).

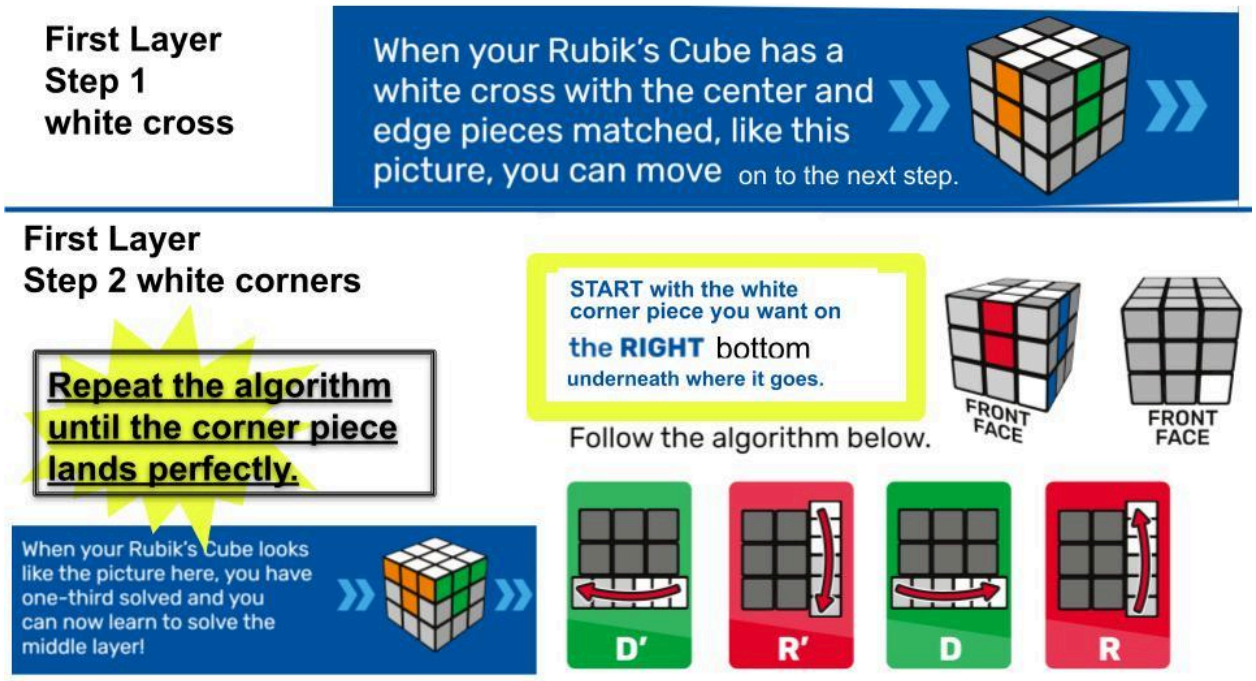
3. Reflection & Resilience Wrap-Up (10 Mins)

- **Debrief:** Share common peer-coaching moments.

- **Resilience Focus:** Reframe frustration: *"When you get stuck, explain what you see out loud to a partner before asking for help."*

    - **Focuses on Observation:** On the Rubik's Cube, troubleshooting requires looking at the physical layout of the colors, edges, and corners. Having a student describe what they see (e.g., "I have a white edge piece on the bottom, but its side color is blue and it's sitting under the red center") forces them to observe the state of the puzzle closely.

    - **Rubber Duck Debugging:** In computer science and logic-based learning, explaining what you see out loud often leads students to spot their own mistake before the partner even answers.



Lesson 3: Middle Layer

Lesson Focus: Flip the cube (Yellow on Top, White on Bottom) and solve the 4 Middle-Layer Edges.

- **Duration:** 60 Minutes
- **Materials Needed:** 3x3 Rubik's Cubes, Streamlined Slide Deck (tinyurl.com/rubikscubeslides)

1. Direct Instruction / Whole Group (20 Mins)

Part A: Flip the Cube

- Flip the cube so the solved **White face is on the bottom** (acting as your solid foundation).
- The **Yellow face** is now on top.

Part B: Build the "T"

- Scan the top (Yellow) layer for an edge piece that **does NOT have yellow** on it.
- Match its front color with its matching center piece to form a tall **"T"** shape on the front face.

Part C: Choose Your Direction (Left or Right)

- Look at the top (secondary, non-yellow) color of that edge piece.

- Look at the center pieces on the left and right sides of your cube. That secondary color will match either the **left center** or the **right center**.

- Decide: *"Does this piece need to go to the LEFT or to the RIGHT?"*

Part D: Execute the Code

- Direct students to the corresponding **Go Left** or **Go Right** code sequence on the slide deck.

- **Teacher Caution:** Remind students: *"This code is 8 steps long, so be extremely careful and follow every single turn in order. If you lose your place, don't panic—just reset your T and check your White base."*

2. Guided Practice & Independent Work (30 Mins)

- Students work through finding non-yellow edges, matching the "T," determining Left vs. Right, and executing the directional codes for all 4 middle edges.

- This is historically the highest-frustration day—encourage peer support and step-by-step verification.

- Teacher and early finishers circulate to help students verify their "T" and catch missteps early in the 8-move sequence.

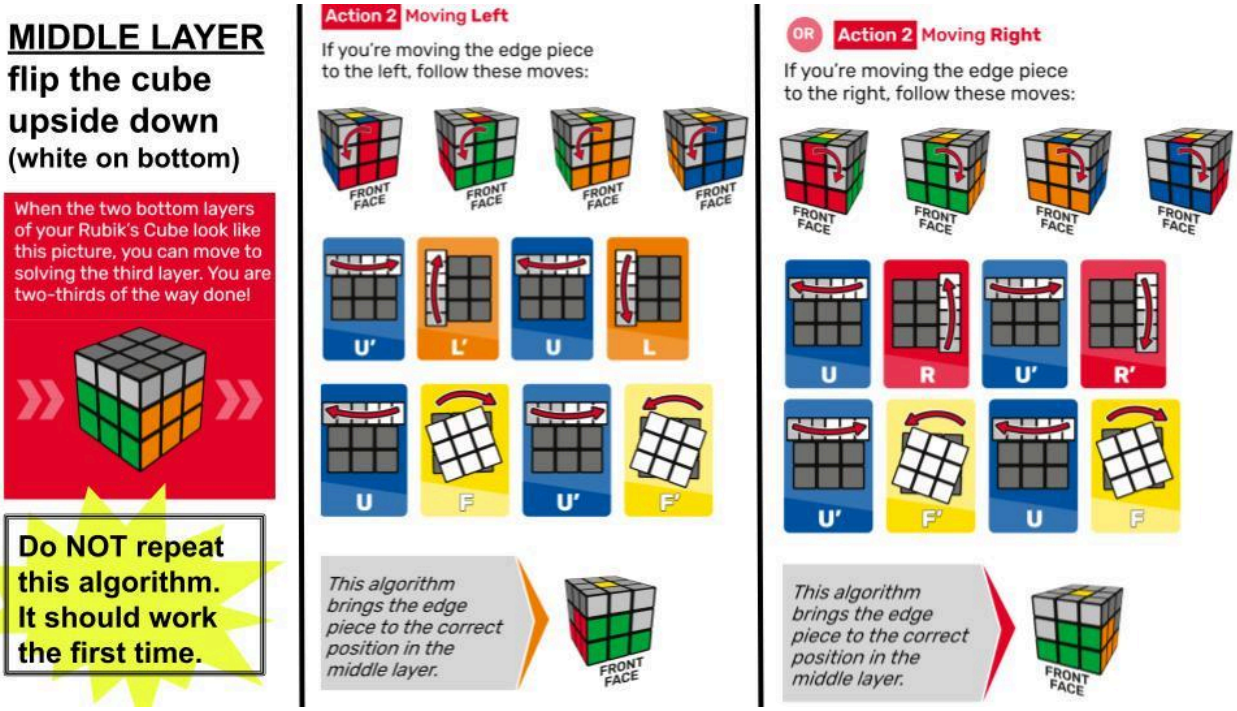
3. Reflection & Resilience Wrap-Up (10 Mins)

- **Debrief:** Ask: *"What happened if you missed just one turn in the 8-move code? How did you recover?"*

- **Debrief:** Celebrate partial success (getting 1 or 2 middle edges in).

- **Resilience Focus:** Emphasize accuracy over speed: *"Executing an 8-move algorithm slowly and correctly saves you from having to fix a scrambled layer later!"*

- **Resilience Focus:** Discuss *Recovery*: *"If you accidentally scrambled your top layer, how quickly can you re-apply your Day 1 and Day 2 steps to get back to where you were?"*



Lesson 4: Top Layer
Yellow Cross & Yellow Corners

Lesson Focus: Orienting the top layer by forming the Yellow Cross and making the entire top face Yellow.

- **Duration:** 60 Minutes
- **Materials Needed:** 3x3 Rubik's Cubes, Streamlined Slide Deck (tinyurl.com/rubikscubeslides)

1. Direct Instruction / Whole Group (20 Mins)

Part A: Identify Your Yellow Top Pattern

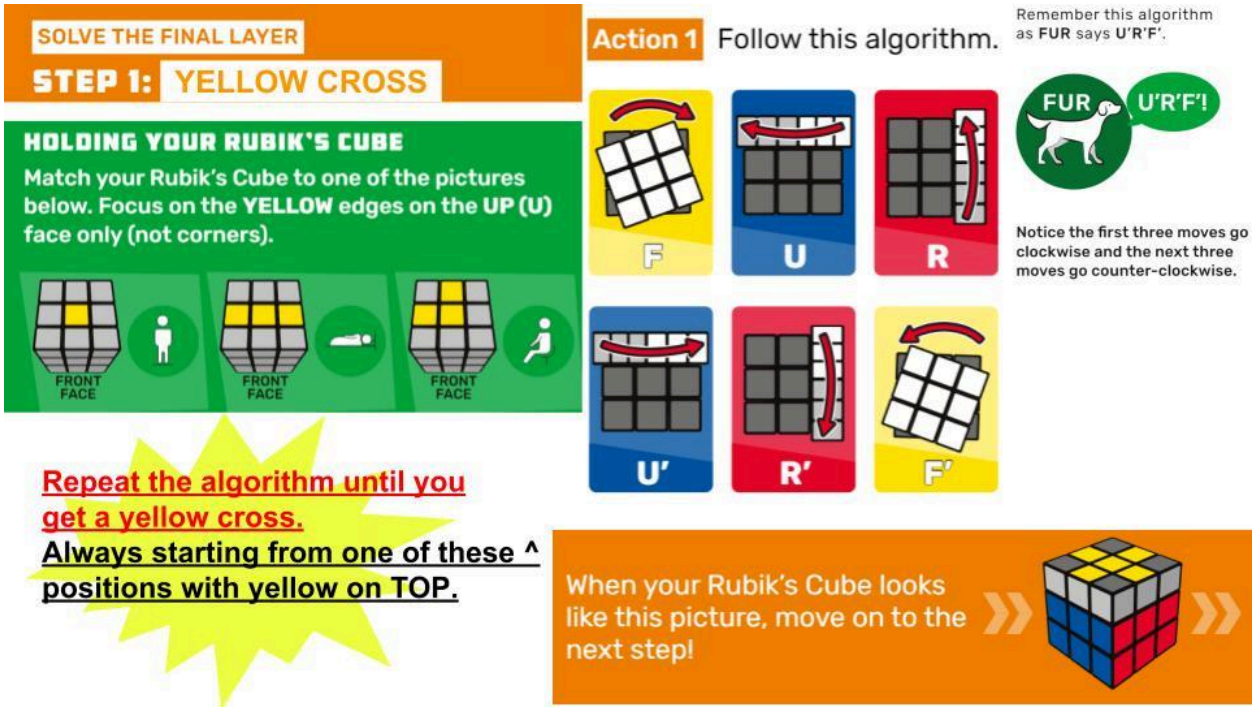
Have students look directly at the top Yellow face. Explain that regardless of how scrambled the top looks, the yellow edges always form one of 4 states:

1. **The Dot:** Just the center yellow piece (no edges matching yet).
2. **The backwards "L" in the top left:** Two yellow edges forming a right angle. *Crucial rule: Hold the cube so the "L" points to the 12 o'clock and 9 o'clock positions (top and left).*
3. **The Line / Bar:** A straight horizontal line of 3 yellow pieces across the center. *Crucial rule: Hold the line horizontally (3 o'clock and 9 o'clock), never vertically.*
4. **The Yellow Cross:** All 4 yellow edges facing up!

Part B: The Yellow Cross Code (F U R U' R' F')

- Show students how executing this single code cycles through the states: **Dot → "L" → Line → Cross**.

- Remind them that if they start at the "L" shape, they only have to execute the code twice to reach the Cross!



Part C: Align Top Corners (The Setup Turn)

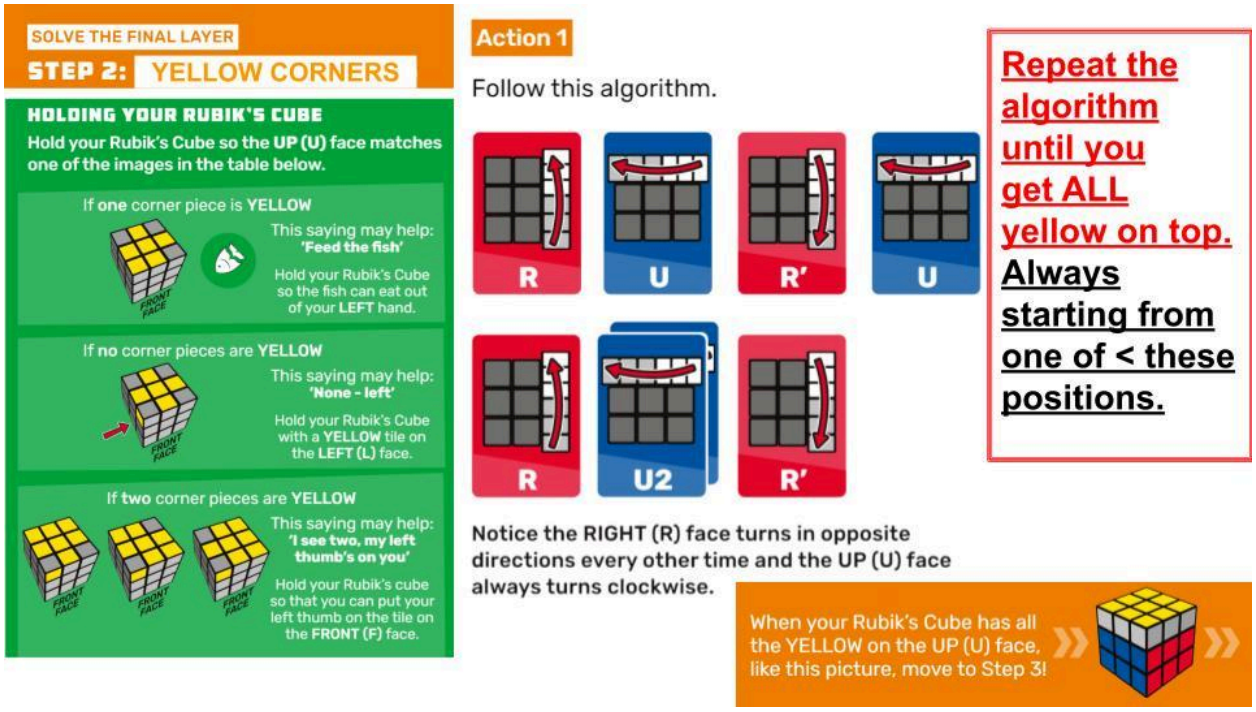
- Once the Yellow Cross is built, inspect how many Yellow corners are already facing up (0, 1, or 2).

- **The "Fish" Rule (1 Yellow Corner Solved):** Turn the top layer (U / U') so the single solved yellow corner is in the **bottom-left corner** facing you (“Feed the Fish").

- **The 0 or 2 Corners Rule:** If you don't have exactly 1 corner solved, turn the top layer so a Yellow corner tile on the front face points towards you on the left side.

Part D: Solve the Yellow Face

- Execute the Yellow Corner algorithm (R U R' U R U2 R')
- If starting from 0 or 2 corners, performing this sequence will create the "Fish" shape. Repeat **Part B** to orient the fish head to the bottom-left, then run the algorithm one last time to make the entire top face solid Yellow!\



2. Guided Practice & Independent Work (30 Mins)

- Students practice identifying their top pattern state and executing the corresponding algorithms.
- Students work through forming the cross, turning their top layer to set up their corners correctly, and completing their full Yellow face.
- Students who achieve a full Yellow face begin assisting peers through pattern identification.

- Teacher and peer coaches check that students are rotating their top layer to place the "Fish Head" in the bottom-left **before** doing their corner code.

3. Reflection & Resilience Wrap-Up (10 Mins)

- **Debrief:** Ask: *"What happened if you executed the corner code without aligning the fish head to the bottom-left first?"*

- **Resilience Focus:** Reframe missteps: *"Aligning your top layer before doing an algorithm is like lining up a key before turning a lock—positioning is everything!"*

- **Resilience Focus:** Emphasize that repetition builds muscle memory: *"Notice how your hands start moving without you having to read every single letter of the algorithm."*

Lesson 5: Positioning Yellow Corners & Edges (Solve the Final Layer)

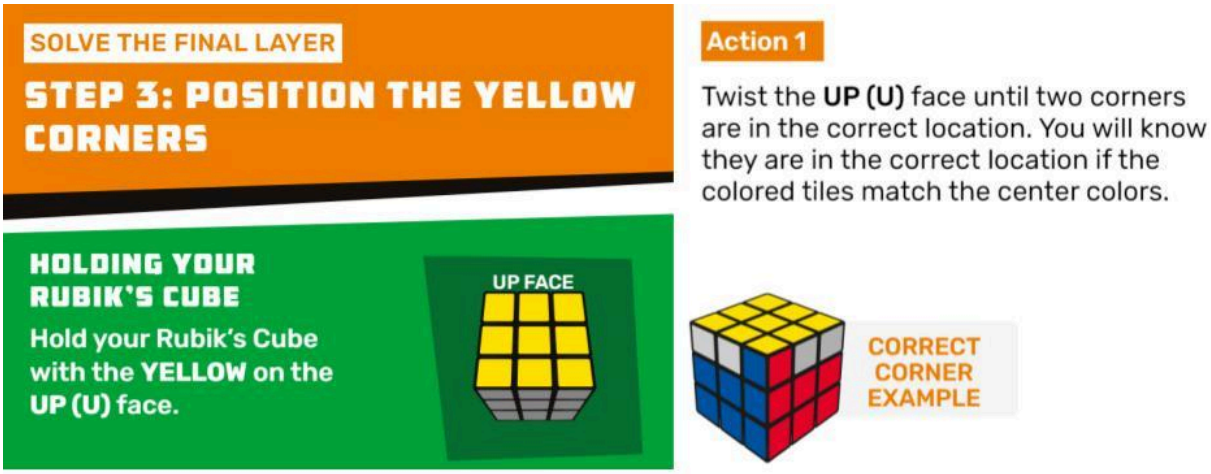
Lesson Focus: Positioning Yellow Corners & Edges to complete the full 3x3 Rubik's Cube solve.

- **Duration:** 60 Minutes
- **Materials Needed:** 3x3 Rubik's Cubes, Streamlined Slide Deck (tinyurl.com/rubikscubeslides), Completion Certificates / Celebration Badges

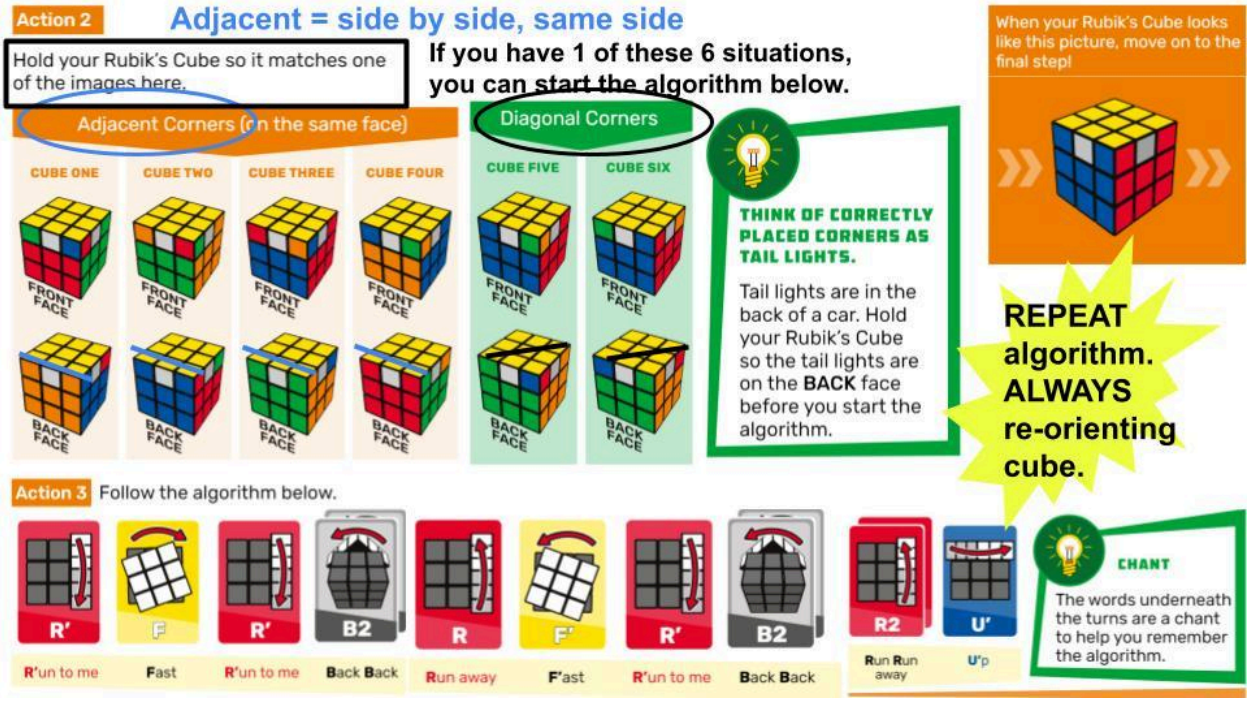
1. Direct Instruction / Whole Group (20 Mins)

Part A: Inspect the 4 Top Yellow Corners

Now that the top face is solid Yellow, look at the outer side colors of the 4 yellow corner pieces. Spin the top layer (U or U') to see how many corners match up with the wall colors:



- Case 1: Two Adjacent Corners Match ("Headlights")
    - You will see two matching corner colors side-by-side on one wall (e.g., two Green corners).
    - Step 1: Turn the top layer to align those matching corners with their matching color wall.
    - Step 2: Put that matching wall in the BACK facing away from you.
    - Step 3: Execute the next algorithm once to fix all 4 corners!
- Case 2: Two Diagonal Corners Match (No Headlights)
    - You look around all 4 walls and no side has two matching corner colors. Instead, if you look diagonally across the top yellow face (e.g., front-left and back-right), those two corners are in their correct color positions relative to each other.
    - Step 1: Hold the cube at ANY angle with Yellow on top. Running the algorithm on diagonal corners automatically shifts the pieces so that you now have **2 adjacent matching corners ("Headlights")**. And you can orient the cube as in Case 1 and do the algorithm again.



Part B: Position the Final Edges

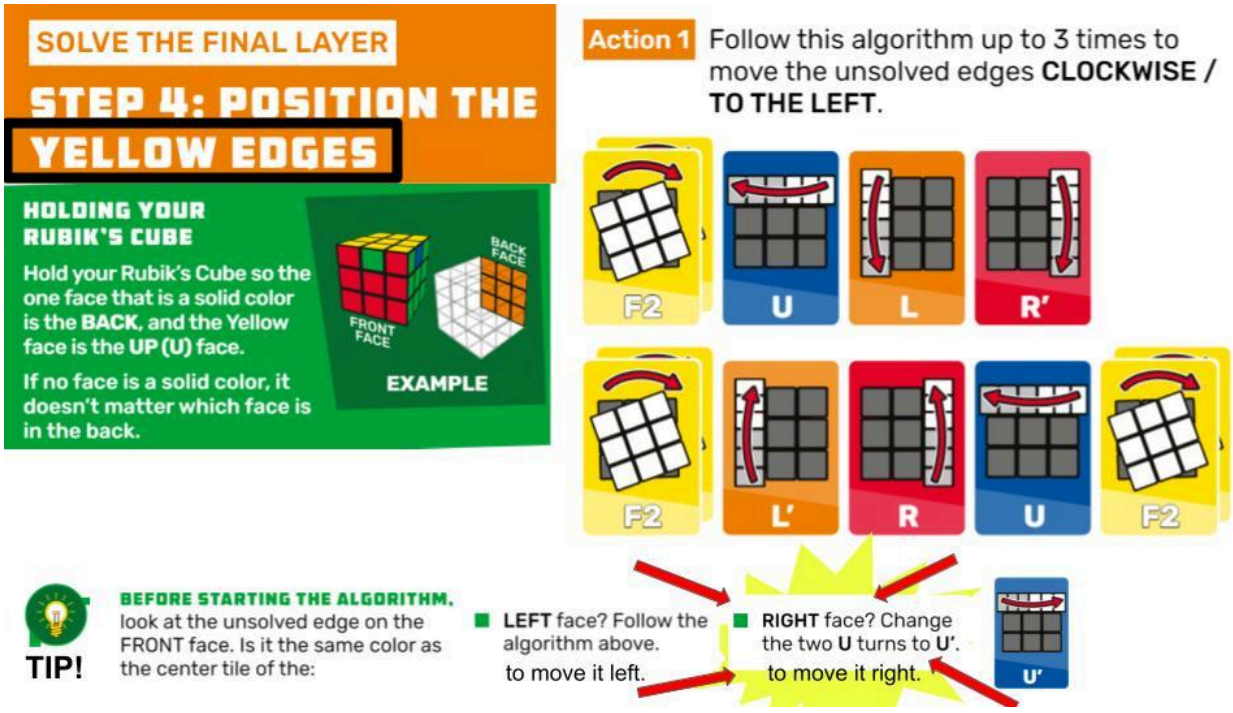
Look at the remaining middle edge pieces on the top layer:

1. **Find the Solved Wall:** If 1 full side wall is completely solved, turn the cube so that solved wall faces the **BACK**. *(Note: If NO wall is solved yet, execute either edge code from any angle to create a solved wall, then put it in the back).*

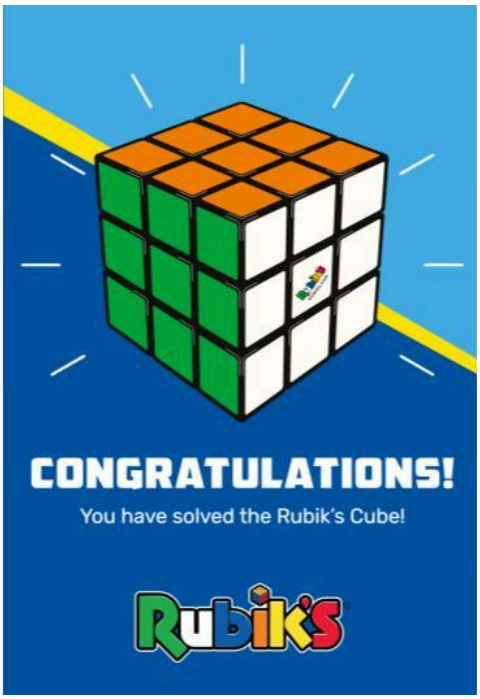
2. **Determine Direction (Left or Right):** Look at the **front edge piece** facing you:

    - **Go Right (Clockwise Cycle):** If that front edge piece needs to move to the **Right** side wall to match its color, execute the **Edge Cycling (Right)** code.

    - **Go Left (Counterclockwise Cycle):** If that front edge piece needs to move to the **Left** side wall to match its color, execute the **Edge Cycling (Left)** code.



Part C: The Final Turn!



- Give the top layer one final alignment turn to match all four full faces!

2. Guided Practice & Celebration (30 Mins)

- Students complete their final solve!
- Solved students immediately transition into **Student Coaches** to help every classmate reach the finish line.
- Time permitted: Run a fun timed-solve or team relay race.

3. Final Reflection & Celebration (10 Mins)

- **Classroom Reflection:** Ask: *"How did your mindset change from Day 1 to Day 5 when facing a difficult challenge?"*
- **Confidence Flex:** Celebrate collective victory and award completion recognition.

Resources



Official Solutions Guide tinyurl.com/rubikscube3x3
Rubiks Cube Slides tinyurl.com/rubikscubeslides
Printable 11x17 poster https://tinyurl.com/rubikscube11x17

rubikscube.com

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Step by Step Videos www.rubiks.com/solution-guides#more-solves

1. Introduction www.youtube.com/watch?v=F-zMjsRgJws
2. White Cross www.youtube.com/watch?v=wkyCH2DKCsQ
3. White Corners: www.youtube.com/watch?v=EqLE2cFJFjI
4. Middle Layer: www.youtube.com/watch?v=hZ70g8HvIOo
5. Yellow Cross: www.youtube.com/watch?v=IlDiR1ItVfw
6. Yellow Corners 1: www.youtube.com/watch?v=xby6INEmrwI&t=8s
7. Yellow Corners 2: www.youtube.com/watch?v=4C0lrqPq4ig
8. Yellow Edges: www.youtube.com/watch?v=5fq84H2UzuU

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$15 speed cube https://a.co/d/04bE2pmi
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