YOU CAN LEARN TO SOLVE THE RUBIK'S CUBE

TEACHER GUIDE

LESSONS INCLUDE:
Get to Know Your Rubik's Cube
Create a Daisy
Create a White Cross
Solve the White Corners
Solve the Middle Layer
Make a Yellow Cross
Orient the Corners
Position the Yellow Corners
Position the Yellow Edges
You CAN Learn to Solve
The Rubik’s® Cube
Teacher Guide

This guide is a companion to PowerPoint presentations found at https://www.youcandothecube.com/educators/teach-to-solve/.

Checklists, videos, songs & chants, and the PowerPoint presentations which appear in this Teacher Guide may be downloaded at no cost at https://www.youcandothecube.com/educators/teach-to-solve/.
# Table of Contents

<table>
<thead>
<tr>
<th>Getting to Know Your Rubik’s Cube</th>
<th>p. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Standards</td>
<td>p. 4</td>
</tr>
<tr>
<td>Lesson Content</td>
<td>p. 5 - 9</td>
</tr>
<tr>
<td>Lesson Extensions &amp; Rubik’s Trivia</td>
<td>p. 9 -10</td>
</tr>
<tr>
<td>Rubik’s Cube Mat</td>
<td>p. 11</td>
</tr>
<tr>
<td>Rubik’s Cube Turn Cards</td>
<td>p. 12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solve Layer One Step 1: Create a Daisy</th>
<th>p. 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Standards</td>
<td>p. 14</td>
</tr>
<tr>
<td>Lesson Content</td>
<td>p. 15 - 18</td>
</tr>
<tr>
<td>Lesson Extensions &amp; Rubik’s Trivia</td>
<td>p. 19</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solve Layer One Step 2: Create a White Cross with matched Edges and Center pieces</th>
<th>p. 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Standards</td>
<td>p. 21</td>
</tr>
<tr>
<td>Lesson Content</td>
<td>p. 22 - 23</td>
</tr>
<tr>
<td>Lesson Extensions &amp; Rubik’s Trivia</td>
<td>P. 24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solve Layer One Step 3: Solve the White Corners</th>
<th>p. 25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Standards</td>
<td>p. 26</td>
</tr>
<tr>
<td>Lesson Content</td>
<td>p. 27 - 29</td>
</tr>
<tr>
<td>Lesson Extensions &amp; Rubik’s Trivia</td>
<td>p. 29 - 30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solve the Middle Layer</th>
<th>p. 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Standards</td>
<td>p. 32</td>
</tr>
<tr>
<td>Lesson Content</td>
<td>p. 33 - 35</td>
</tr>
<tr>
<td>Lesson Extensions &amp; Rubik’s Trivia</td>
<td>p. 35</td>
</tr>
<tr>
<td>Track the Rubik’s Cube</td>
<td>p. 36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solve the Final Layer Step 1: Make a Yellow Cross</th>
<th>p. 37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Standards</td>
<td>p. 38</td>
</tr>
<tr>
<td>Lesson Content</td>
<td>p. 39</td>
</tr>
<tr>
<td>Lesson Extensions &amp; Rubik’s Trivia</td>
<td>p. 39</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solve the Final Layer Step 2: Orient the Corners</th>
<th>p. 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content Standards</td>
<td>p. 41</td>
</tr>
<tr>
<td>Lesson Content</td>
<td>p. 42</td>
</tr>
<tr>
<td>Lesson Extensions &amp; Rubik’s Trivia</td>
<td>p. 43 - 44</td>
</tr>
</tbody>
</table>
Below are some of the learning standards that are addressed by learning to solve a Rubik's Cube.

### 21st Century Skills

<table>
<thead>
<tr>
<th>Communication and Collaboration</th>
<th>Critical Thinking and Problem Solving</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade)</td>
<td>● Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation</td>
</tr>
<tr>
<td>● Demonstrate ability to work effectively and respectfully with diverse teams</td>
<td>● Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Creativity and Innovation</th>
<th>Information, Media, and Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Elaborate, refine, analyze and evaluate students’ own ideas in order to improve and maximize creative efforts</td>
<td>● Evaluate information critically and competently</td>
</tr>
<tr>
<td>● View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes.</td>
<td>● Use information accurately and creatively for the issue or problem at hand</td>
</tr>
</tbody>
</table>

### American Association of School Librarians

<table>
<thead>
<tr>
<th>I. INQUIRE</th>
<th>V. EXPLORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Build new knowledge by inquiring, thinking critically, identifying problems, and developing strategies for solving problems.</td>
<td>● Discover and innovate in a growth mindset developed through experience and reflection.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>III. COLLABORATE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>● Work effectively with others to broaden perspectives and work toward common goals.</td>
<td></td>
</tr>
</tbody>
</table>

### Social & Emotional Learning Standards

<table>
<thead>
<tr>
<th>Self-management:</th>
<th>Relationship skills:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● The ability to regulate one’s emotions, thoughts, and behaviors effectively in different situations. This includes managing stress, controlling impulses, motivating oneself, and setting and working toward achieving personal and academic goals.</td>
<td>● The ability to establish and maintain healthy and rewarding relationships with diverse individuals and groups. This includes communicating clearly, listening actively, cooperating, resisting inappropriate social pressure, negotiating conflict constructively, and seeking and offering help when needed.</td>
</tr>
</tbody>
</table>
Learning to Solve

Get to Know Your Rubik’s® Cube

Grab your guide, your mat, and a Rubik’s Cube. Let’s get started!

©1974 Rubik’s® Used under license Rubik’s Brand Ltd. All rights reserved.

A sample mat may be found at the end of this lesson on p. 11.

Get to Know Your Rubik’s® Cube

In this lesson, you will learn:

- the parts of the Rubik’s Cube
- how to move the Rubik’s Cube
- what the turns are called
- some ways to remember the turns
<table>
<thead>
<tr>
<th>Grade</th>
<th>Common Core Content</th>
<th>National Council of Teachers of Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>K - 2</td>
<td>K.CC.5 - Answer “how many” questions</td>
<td>Number and Operations</td>
</tr>
<tr>
<td></td>
<td>K.MD.1 - Measurable attributes of objects</td>
<td>• recognize “how many” in sets of objects</td>
</tr>
<tr>
<td></td>
<td>K.G.1 - Describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to</td>
<td>Algebra</td>
</tr>
<tr>
<td></td>
<td>K.G.2 - Partition a rectangle into rows and columns of same size squares</td>
<td>• sort, classify, and order objects by properties</td>
</tr>
<tr>
<td></td>
<td>K.G.3 - Identify shapes as two-dimensional</td>
<td>Geometry</td>
</tr>
<tr>
<td></td>
<td>K.G.4 - Compare two- and three-dimensional shapes</td>
<td>• recognize, name, build, draw, compare, and sort two- and three-dimensional shapes</td>
</tr>
<tr>
<td></td>
<td>1.G.1 - Defining attributes of shapes</td>
<td>• describe attributes and parts of two- and three-dimensional shapes,</td>
</tr>
<tr>
<td></td>
<td>2.G.2 - Compare two- and three-dimensional shapes</td>
<td>• recognize shapes from different perspectives</td>
</tr>
<tr>
<td>3 - 5</td>
<td>3.MD.1 - Tell time</td>
<td>Geometry</td>
</tr>
<tr>
<td></td>
<td>4.G.1 - Identify angles, perpendicular and parallel lines in two-dimensional figures</td>
<td>• identify attributes of two- and three-dimensional objects; develop vocabulary to describe the attributes.</td>
</tr>
<tr>
<td></td>
<td>5.NF.4b - Area of a rectangle using unit squares</td>
<td>• understand relationships among angles, side lengths, perimeters, area, and volume</td>
</tr>
<tr>
<td></td>
<td>5.MD.3 - Volume of a cube</td>
<td>• describe objects and patterns</td>
</tr>
<tr>
<td></td>
<td>5.G.3 - Attributes of two-dimensional figures</td>
<td>Measurement</td>
</tr>
<tr>
<td></td>
<td>6.G.2 - Volume of a right rectangular prism</td>
<td>• understand attributes such as length, area, weight, and volume</td>
</tr>
<tr>
<td>6 - 8</td>
<td>6.G.2 - Volume of a right rectangular prism</td>
<td>Geometry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• precisely describe two- and three-dimensional objects using their attributes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• use two-dimensional representations of three-dimensional objects to solve volume and surface problems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measurement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• select appropriate units to measure perimeter, area, surface area, and volume</td>
</tr>
</tbody>
</table>
Lesson Content:
The questions on these slides are meant to focus students on the characteristics of the Rubik’s Cube. Depending on the grade level of your students, these questions may or may not be appropriate. Many of the slides are animated so what you see in this guide may not appear all at once in the presentation.

Slides 3 - 5

Get to know the pieces

In this guide, you will see pictures of a Rubik’s Cube with gray pieces.

The gray areas on the Rubik’s Cube mean that at the stage you are working on, the color of the gray pieces doesn’t matter.

The difference between layers and faces can be confusing. The cake analogy may help. Layers of the Rubik's Cube are like layers of a cake. Faces are the frosting on the cake.

Get to know the pieces

Each side is called a face. How many faces are there? What shape is each face?

You can place your palm flat on a FACE.

What angle measures do the faces make?

Each of the six faces or sides of the Rubik’s Cube is a square. The faces are perpendicular to one another forming 90° angles.
Get to Know Your Rubik’s Cube

Slides 6 - 9

While this may seem obvious, beginning solvers often confuse the pieces so time is well spent on these slides.

There are 6 Center pieces. It is important to note that the Centers indicate the color when the face is solved.

There are 12 Edge pieces. Stress that Edge pieces have 2 colors. Ask students what color combinations could not be Edge pieces. (For example, there will be no Blue/Green edge pieces because Blue and Green are opposite faces.)

Realizing that the colors are in this orientation is very helpful when solving. It will help more experienced learners determine which turn to make to be most efficient as they look for other methods to solve.

There are 8 Corner pieces. Corner pieces have 3 colors. Corners will have either one White tile or one Yellow tile. You may want to introduce the term vertex with older students. With younger students, have them identify the point that Corners have. Edges do not have points.

www.youcandothecube.com

©1974 Rubik’s® Used under license Rubik’s Brand Ltd. All rights reserved
Slides 10 - 15

It is critical that students realize that any color face could be in any of the locations below. For this reason, it is best to have students keep their Rubik's Cube on a flat surface so they do not lose the orientation. The mat at the end of the lesson, p. 11, is a good tool to reinforce maintaining the Rubik's Cube's orientation as students solve.
Each turn of the face of a Rubik's Cube is a clockwise turn as if you are looking at the face. You may want to put small clock faces on the sides of the cube for younger students. With older students, you may want to use mental imagery of the clock face on the cube face.

**HINT:** Have students place their flat palms on the face you want them to turn. This is a good strategy to use at any stage of solving the Rubik's Cube.

A counterclockwise or inverse turn is always indicated by an apostrophe following the turn letter.

A mental image is provide for each turn.
Slides 21 - 26
The Turn Cards and the mat are two examples of the downloadable resources on the Teach to Solve of the You CAN Do the Rubik's Cube website. Both can be found at the end of this lesson as well, p. 11 & 12. https://www.youcandothecube.com/educators/teach-to-solve/

At the end of most lessons, there are lesson extensions and a Rubik's Cube Trivia question.
Encourage students to practice their new skills before moving on to the next lesson. At this point, you may want them to:

- Use the Turn Memory Game to create algorithms for one another to follow, p. 12

Other suggested lessons downloadable at no cost at: https://www.youcandothecube.com/educators/rubiks-cube-units-and-lessons

- Elementary STEM Unit
- Middle School Stem Unit
- Rubik’s Cube Study: The Geometry, the Art, the Solution
- Fraction Models Lesson
- Working with Constraints
- Measurement Lesson - Area, Surface Area, Volume
- Deconstructing Prisms
- and more!

For the lesson pictured, use the content filter “English Language Arts.”
Rubik’s® Cube Mat
Make a copy of the mat for each student. Have students keep their Rubik’s Cubes on the mat as they solve. This will help them maintain the correct orientation of the Rubik’s Cube for each stage of solving. Two mats have been provided here.
Rubik’s® Cube Turn Cards
Make copies of the cards. Have students play "Concentration" with them. Students could use the cards as a way to "record" their algorithms. This page could be a good poster or reference sheet.
Learning to Solve

Solve Layer One
Step 1: Create a Daisy

Grab your guide, your mat, and a Rubik’s® Cube. Let’s get started!

©1974 Rubik’s® Used under license Rubik’s Brand Ltd. All rights reserved.

Solve Layer One
Step 1: Create a Daisy

In this lesson, you will learn

- how the EDGE pieces move
- how to move a piece out of the way so a new piece can be placed
- about a new turn

©1974 Rubik’s® Used under license Rubik’s Brand Ltd. All rights reserved
<table>
<thead>
<tr>
<th>Grade</th>
<th>Common Core CCSS.MATH.CONTENT</th>
<th>National Council of Teachers of Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>K - 2</td>
<td><strong>K.G.1</strong> Names of shapes</td>
<td><strong>Geometry</strong></td>
</tr>
<tr>
<td></td>
<td><strong>1.G.1</strong> Defining attributes of shapes</td>
<td>• describe attributes and parts of two- and three- dimensional shapes</td>
</tr>
<tr>
<td></td>
<td><strong>1.OA.B.3</strong> Apply properties of operations as strategies</td>
<td>• create mental images of geometric shapes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• recognize shapes from different perspectives</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• relate ideas in geometry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• recognize geometric shapes in the environment</td>
</tr>
<tr>
<td>3 - 5</td>
<td><strong>3.OA.B.5</strong> Apply properties of operations as strategies</td>
<td><strong>Geometry</strong></td>
</tr>
<tr>
<td></td>
<td><strong>4.OA.C.5</strong> Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself.</td>
<td>• identify attributes of two- and three- dimensional objects; develop vocabulary to describe the attributes</td>
</tr>
<tr>
<td></td>
<td><strong>4.G.1</strong> Identify angles, perpendicular and parallel lines in two-dimensional figures</td>
<td>• describe objects and patterns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• recognize geometric ideas and apply them in the classroom and everyday life</td>
</tr>
<tr>
<td>6 - 8</td>
<td><strong>6.EE.A.3</strong> Apply the properties of operations to generate equivalent expressions</td>
<td><strong>Geometry</strong></td>
</tr>
<tr>
<td></td>
<td><strong>6.EE.A.4</strong> Identify when two expressions are equivalent</td>
<td>• precisely describe two- and three- dimensional objects using their attributes</td>
</tr>
<tr>
<td></td>
<td><strong>7.EE.A.2</strong> Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related</td>
<td></td>
</tr>
</tbody>
</table>
Solve Layer One  Step 1: Create a Daisy

Lesson Content:

These slides present an opportunity to think purposefully about how the Rubik’s Cube moves. The number of tiles on a piece determines the number of faces you can turn to move that piece. Depending on the grade level of your students, the questions on the slides may or may not be appropriate. The focus here is on Edge pieces which are used to make the daisy. Many of the slides are animated so what you see in this guide may not appear all at once in the presentation.

Slides 3 – 5

These 2 hints apply whenever students are working with the Rubik’s Cube.

**HINT:** Have students place their flat palms on the face you want them to turn. This is a good strategy to use at any stage of solving the cube.

**HINT:** Keeping the Rubik’s Cube on the table or desk may help students maintain consistent orientation of it which is an important concept as they solve. Using the mat on p. 11 may also help.

An F turn will put the Yellow tile on the Yellow-Red Edge on the RIGHT face. An F’ turn will put the Yellow-Red Edge back on the FRONT and UP faces.

A U turn or a U’ turn will move the Yellow-Red Edge.

Since the Red tile of the Red-Green Edge is on the FRONT face either an F or F’ turn will move the Red-Green Edge. The Green tile is on the RIGHT face so either an R or R’ turn will also move the Red-Green Edge. Only the R turn or 3 R’ turns will put the Red tile on the UP face.
Solve Layer One  Step 1: Create a Daisy

There are many resources that state that making the daisy is intuitive. While many solvers find it fairly easy, a more deliberate approach to creating the daisy is taken in this guide.

To make the Daisy, the Yellow face, indicated by the Yellow Center, must be the **UP** face.

Now that you have the Yellow Center, you need the White petals. Using what was learned about how Edge pieces move, students will locate the Edge pieces with White tiles, layer by layer, and move those Edges to the **top** layer.

If the White tile is in the **top** layer but not on the **UP** face, that is okay at this point.

**HINT:** Have students place their flat palms on the face you want them to turn. This is a good strategy to use at any stage of solving the cube.

**HINT:** Keeping the Rubik’s Cube on the table or desk may help students maintain consistent orientation of it which is an important concept as they solve. Using the mat on p. 11 may also help.

[Image of a daisy and Rubik’s Cube]

https://unsplash.com/@colteroinstead

---

www.youcandothecube.com

©1974 Rubik’s® Used under license Rubik’s Brand Ltd. All rights reserved
Solve Layer One  Step 1: Create a Daisy

Since we are going to want the White tile on the UP face, one of these turns is more efficient than the other. R will move the White tile to the UP face which is the ultimate goal.

Throughout the guide, we often move a pieces “out of the way” in order to move the desired piece into its correct location. Here the U’ turn moves a White tile out of the way so another White tile can be moved to the UP face.

HINT: Have students place their flat palms on the face you want them to turn. This is a good strategy to use at any stage of solving the cube.

HINT: Keeping the Rubik’s Cube on the table or desk may help students maintain consistent orientation of it which is an important concept as they solve. Using the mat on p. 11 may also help.

Before making the F2 turns, have students check that another White tile is not already in the top layer of the FRONT face. To avoid the “bump” situation, a U turn will move the White tile out of the way so that the White tile in the bottom layer can be moved to the top layer.
In this last step, any Edges in the top layer that do not have the WHITE tile on the UP face will be flipped so WHITE is on the UP face.

Most of the algorithms in this guide require the piece that is being moved begin on the RIGHT face. Students will reorient the entire Rubik’s Cube on their mats, **not make any turns**, to place the piece on the RIGHT face.

Have students practice making the daisy until they are confident in this skill. As they progress throughout the guide, they may need to redo steps to correct mistakes. It is less frustrating to do this if they are confident in the prior skills.
Have students make other “flowers” – such as a red center with orange petals or a yellow center with green petals.

The first action is always to place the desired color Center on the UP face. Then go layer by layer to place the petals.

The UP faces on the slide are more difficult because the petals are not the same color and must be in a particular orientation around the Center.
Learn to Solve

Solve Layer One
STEP 2:
Create a WHITE Cross with matched edges and center pieces

In this lesson you will learn:

- how to match Edges on the top layer with the Center pieces that have the same color
- how to “undo” the daisy to create the WHITE Cross
**CONTENT STANDARDS & SKILLS: Solve Layer One Step 2:**
Create a White Cross with matched Edges and Center pieces

<table>
<thead>
<tr>
<th>Grade</th>
<th>Common Core</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K - 2</strong></td>
<td><strong>CCSS.MATH.CONTENT</strong></td>
</tr>
<tr>
<td></td>
<td><strong>K.G.1</strong> Names of shapes</td>
</tr>
<tr>
<td></td>
<td><strong>1.G.1</strong> Defining attributes of shapes</td>
</tr>
<tr>
<td></td>
<td><strong>1.OA.B.3</strong> Apply properties of operations as strategies</td>
</tr>
<tr>
<td></td>
<td><strong>National Council of Teachers of Mathematics</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Geometry</strong></td>
</tr>
<tr>
<td></td>
<td>• describe attributes and parts of two- and three- dimensional shapes</td>
</tr>
<tr>
<td></td>
<td>• create mental images of geometric shapes</td>
</tr>
<tr>
<td></td>
<td>• recognize shapes from different perspectives</td>
</tr>
<tr>
<td></td>
<td>• relate ideas in geometry</td>
</tr>
<tr>
<td></td>
<td>• recognize geometric shapes in the environment</td>
</tr>
</tbody>
</table>

| **3 - 5** | **3.OA.B.5** Apply properties of operations as strategies |
| | **4.OA.C.5** Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. |
| | **4.G.1** Identify angles, perpendicular and parallel lines in two-dimensional figures |
| | **Geometry** |
| | • identify attributes of two- and three-dimensional objects; develop vocabulary to describe the attributes |
| | • describe objects and patterns |
| | • recognize geometric ideas and apply them in the classroom and everyday life |

| **6 - 8** | **6.EE.A.3** Apply the properties of operations to generate equivalent expressions |
| | **6.EE.A.4** Identify when two expressions are equivalent |
| | **7.EE.A.2** Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related |
| | **8.G.A.1** Verify experimentally the properties of rotations, reflections, and translations |
| | **Geometry** |
| | • precisely describe two- and three-dimensional objects using their attributes |
SOLVE LAYER ONE STEP 2: Create a White Cross with matched Edges and Center pieces

In this lesson, students remove the daisy, petal by petal, to create the White Cross on the opposite or DOWN (D) face. In the beginning, this may be disconcerting to students. Reassure them that removing the daisy is part of the process. From this point on, anything created will remain. Many of the slides are animated so what you see in this guide may not appear all at once in the presentation.

Slides 3 - 5

HINT: Have students place their flat palms on the face you want them to turn. This is a good strategy to use at any stage of solving the cube.

HINT: Keeping the Rubik’s Cube on the table or desk may help students maintain consistent orientation of it which is an important concept as they solve. Using the mat on p. 11 may also help.

In ACTION 1, have students focus on the color of the Center tile on the FRONT face. Then have them look at the non-White Edge tile of the top layer to see if it is the same color as the Center. If it not the same color, then they will make U turns until the two tiles match.

Once the Edge and Center tiles match, turn the FRONT face 180 degrees by making 2 F turns (F2). This will be the first time students see the F2 notation. Students may be concerned that the daisy is beginning to disappear. Reassure them that this is supposed to happen.
SOLVE LAYER ONE STEP 2: Create a White Cross with matched Edges and Center pieces

Slides 6 - 9

Repeat ACTIONS 1 & 2 until all 4 Edges have been matched and turned.

With each subsequent lesson, it is critical to check that the previous stage remains intact before moving on. Look for the reminders throughout the guide.

While all of these patterns can be made on an UP face, none of the non-White Edge pieces will match the color of their Centers. It is a good challenge to have students prove that those tiles can’t match their Centers. You might have students use the ”How well do you know the Rubik’s Cube?” worksheet on p. 24.

For example, the second pattern is impossible because the Yellow Edges would have to have Green and Blue tiles. Blue and Green are opposite, not adjacent. You can’t have a Yellow-Red Edge because it couldn’t match the Red Center because the Red Center is on the UP face. Orange is opposite Red so there can’t be a Yellow-Orange Edge.
How well do you know the Rubik's® Cube?

Here’s a Rubik’s Cube with a completed White Cross. The gray tiles could be any of the Rubik’s Cube colors. It doesn’t matter for this activity.

Color the hidden faces of the Rubik’s Cube above.
Learning to Solve

Solve Layer One
STEP 3: Solve the WHITE Corners

- how to place corners in the bottom layer
- how to match a corner to its correct location and move it into place
- what you can do if you know how to solve one face

In this lesson you will learn:
<table>
<thead>
<tr>
<th>Grade</th>
<th>Common Core CCSS.MATH.CONTENT</th>
<th>National Council of Teachers of Mathematics</th>
</tr>
</thead>
</table>
| K - 2 | K.G.B.4 Analyze and compare two- and three- dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/“corners”) and other attributes (e.g., having sides of equal length) | Operations & Algebraic Thinking  
• recognize, describe and extend patterns  
• analyze how patterns are generated  
Geometry  
• use visualization, spatial reasoning & geometric modeling to solve problems. |
| 3 - 5 | 1-3.G.A. Reason with shapes and their attributes | Number & Operations  
• understand meanings of operations and how they relate to one another  
Algebra  
• analyze change in various contexts  
Geometry  
• predict and describe the results of sliding, flipping, & turning two- dimensional shapes |
| 6 - 8 | 8.G.A.1 Verify experimentally the properties of rotations, reflections, and translations | Number & Operations  
• understand and use inverse relationships  
Geometry  
• precisely describe two- and three- dimensional objects using their attributes  
• create & critique inductive & deductive arguments concerning geometric ideas & relationships |
The big questions for this lesson are

- How do you know where the correct location for each Corner is?
- Do you still have the White Cross?

As in the previous lessons, please note that many of the slides are animated so what you see in this guide may not appear all at once in the presentation.

**Slides 3 - 5**

**Correct Corner Placement**

The correct placement of a corner piece is between center pieces with the same colors. Notice on the image how a red/blue/white corner goes between the red, blue, and white center pieces.

**HINT:** Have students use their mats and keep their Rubik's Cubes on the mat.

**HINT:** Have students place their flat palms on the face you want them to turn.

The goal is to get all 4 Corners placed correctly in the top layer. We will place one corner at a time.

**ACTION 1**

Locate a corner piece with a WHITE tile in the bottom layer.

If your corner piece is in any of these positions, then you're ready for ACTION 2. If your corner piece does NOT match any of these then...

Notice that the Rubik's Cube is held so that the Corner with the White tile is on the FRONT-RIGHT. The White tile may be in any one of these 3 locations. If there are no Corner pieces with White tiles in the bottom layer, go to slides 6 & 7.
SOLVE LAYER ONE  STEP 3: Solve the WHITE Corners

Slides 6 - 9

Note that the entire Rubik’s Cube is placed on the mat so that the Corner with the White tile is on the FRONT-RIGHT faces. No turns are made. The White tile could be in any of the three positions of the Corner.

CAUTION: If the White Cross has come undone, students will need to go back to recreate the daisy and the White Cross.

Now that the Corner is on the bottom layer, have students make sure the White tile is on the FRONT face, either on the left or right. If White is on the DOWN (D) face, the next slide will put it on the FRONT face.

CAUTION: If the WHITE Cross has come undone, students will need to go back to recreate the daisy and the WHITE Cross.
SOLVE LAYER ONE  STEP 3: Solve the WHITE Corners

One of these algorithms will place the Corner in its proper location. Make sure students check to see that the White Cross is still intact after placing each Corner.

These are 2 examples of the lessons that can be found on our website. They provide students the opportunity to practice their new skills in fun and creative ways.
SOLVE LAYER ONE  STEP 3: Solve the WHITE Corners

A permutation of 3 “objects” (White, Green, Orange tiles) would result in 6 arrangements. Have students color the possibilities, perhaps on a copy the 3rd cube pictured on this slide.

Challenge older students to explain how the number of combinations is calculated. The YouTube video link below explains the formula.

https://www.youtube.com/watch?time_continue=35&v=nqHoBXHihPM&feature=emb_logo

\[ \frac{[(12! \cdot 2^{12}) (8! \cdot 3^8)]}{2 \cdot 2 \cdot 3} \]

Now that your students have solved the White face, have them practice these skills by creating a mosaic with Rubik’s Cubes. We have ready-made templates or students can create their own. Go to our website and select the MOSAICS tab to take advantage of all our resources.

Learning to Solve

Solve the Middle Layer

In this lesson you will learn:

- how inverse operations are used to solve the Rubik’s Cube
- how to place the Edges in the Middle Layer
<table>
<thead>
<tr>
<th>Grade</th>
<th>Common Core CCSS.MATH.CONTENT</th>
<th>National Council of Teachers of Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>K - 2</td>
<td>K.G.B.4 Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/“corners”) and other attributes (e.g., having sides of equal length)</td>
<td>Operations &amp; Algebraic Thinking • recognize, describe and extend patterns • analyze how patterns are generated Geometry • use visualization, spatial reasoning &amp; geometric modeling to solve problems</td>
</tr>
<tr>
<td>3 - 5</td>
<td>1-3.G.A. Reason with shapes and their attributes 3.NF.A.1 Understand a fraction 1/b as the quantity formed by 1 part when a whole is partitioned into “b” equal parts; understand a fraction a/b as the quantity formed by “a” parts of size 1/b 3.NF.A.3 Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size 4.G.A.3 Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry</td>
<td>Number &amp; Operations • understand meanings of operations and how they relate to one another Algebra • analyze change in various contexts Geometry • predict and describe the results of sliding, flipping, &amp; turning two-dimensional shapes</td>
</tr>
<tr>
<td>6 - 8</td>
<td>6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values 7.NS.A.1.A Describe situations in which opposite quantities combine to make 0 8.G.A.1 Verify experimentally the properties of rotations, reflections, and translations</td>
<td>Number &amp; Operations • understand and use inverse relationships Geometry • precisely describe two- and three-dimensional objects using their attributes • create &amp; critique inductive &amp; deductive arguments concerning geometric ideas &amp; relationships</td>
</tr>
</tbody>
</table>
There are two similar algorithms for solving the Middle Layer, one for the **LEFT-FRONT** and one for the **RIGHT-FRONT**. This is one of several places where the algorithms seem to make a move and later "undo" the move. This allows pieces to be relocated without displacing correctly placed pieces. Many of the slides are animated so what you see in this guide may not appear all at once in the presentation. Please modify your presentation to best meet the needs of your students.

**Slides 3 - 5**

HINT: Have students use their mats and keep their Rubik’s Cubes on the mat.

HINT: Have students place their flat palms on the face you want them to turn.

Notice each pair of the vertical columns has different colored tiles on the UP face that match the centers on either the **LEFT** face or the **RIGHT** face. None of the tiles at the top of the vertical column is Yellow.

Notice that the piece that needs to be swapped is placed on the **FRONT-RIGHT**. Then follow the algorithm for moving the top Edge to the **FRONT-RIGHT** in the middle layer, on p. 11 in the guide or slide 8 in the presentation.
Solve the Middle Layer

ACTION 2

Now decide where the EDGE at the top of the vertical column belongs. For example...

- The RED GREEN Edge belongs on the LEFT because the RED Center is to the left of GREEN when YELLOW is UP.
- The ORANGE GREEN Edge belongs on the RIGHT because the ORANGE Center is to the right of GREEN when YELLOW is UP.

ACTION 2: Moving Left

If you're moving the edge piece to the left, follow these moves:

- U' L' U L

ACTION 2: Moving Right

If you're moving the edge piece to the right, follow these moves:

- U R U' R'

It may help students remember the algorithms if they notice that in both algorithms the second pair of moves in each row are the inverses of the first pair. For example, U L is the inverse of U' L' and U' F' is the inverse of U F.

ACTION 3

Flip your Rubik's Cube over to check that you still have the WHITE face before placing the next Edge. If you do, flip it back so YELLOW is on the Up face.

If the WHITE face has disappeared, you'll need to go back and fix it. This can be frustrating! But if you persevere and practice, you will be successful!

Repeat Action 1 (making a vertical line) and then

- Action 2 (moving the middle edge into position)

until the two bottom layers of your Rubik's Cube look like this picture.

Beginning solvers should check to see that the White face is intact after each Edge piece is placed in the Middle Layer. As students become more skilled, they are less likely to make mistakes and will no longer need to check.

www.youcandothecube.com
©1974 Rubik's® Used under license Rubik's Brand Ltd. All rights reserved
Solve the Middle Layer

The images to the right of the slide are from p. 11 in the solution guide. Students may benefit from the Rubik’s Cube Tracking lesson. The worksheet is included here on p. 36. Teacher pages for the Tracking lesson may be found on p. 7 & 8 of the Cracking the Code: Solving a Rubik’s Cube lesson which can be found using the "Solve" filter at https://www.youcandothecube.com/educators/rubiks-cube-units-and-lessons/.
Solve the Middle Layer

Track the Rubik's® Cube

Example: First, color all the Center tiles. Then, mark the tile you want to track.

The Red Center will always be on the front in this example.

Made these turns: \( FR'U' \)  
(R' & U' did not move the X.)

Then made these turns \( F'L' \)

Then made these turns: \( UB \)  
Since you can't see the X from the FRONT view, you need to show the BACK view.

www.youcandothecube.com  
©1974 Rubik's® Used under license Rubik's Brand Ltd. All rights reserved
Learning to Solve

Solve Final Layer
STEP 1:
Make a Yellow Cross

• how to place Yellow edges in the top layer
• how to position your Rubik’s Cube before you begin the algorithm.

www.youcandothecube.com
©1974 Rubik’s® Used under license Rubik’s Brand Ltd. All rights reserved
<table>
<thead>
<tr>
<th>Grade</th>
<th>Common Core CCSS.MATH.CONTENT</th>
<th>National Council of Teachers of Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>K - 2</td>
<td>K.G.B.4 Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/&quot;corners&quot;) and other attributes (e.g., having sides of equal length)</td>
<td>Algebra • recognize and describe patterns Geometry • use visualization, spatial reasoning and geometric modeling to solve problems</td>
</tr>
<tr>
<td>3 - 5</td>
<td>5.G.B.3 Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category</td>
<td>Algebra • analyze change in various contexts Geometry • predict and describe the results of sliding, flipping, and turning two-dimensional shapes</td>
</tr>
<tr>
<td>6 - 8</td>
<td>7.G.B.5 Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure 8.G.A.1 Verify experimentally the properties of rotations, reflections, and translations</td>
<td>Algebra • represent and analyze mathematical situations and structures using symbolic language Geometry • create and critique inductive and deductive arguments concerning geometric ideas and relationships</td>
</tr>
</tbody>
</table>

www.youcandothecube.com
©1974 Rubik’s® Used under license Rubik’s Brand Ltd. All rights reserved
The key to this lesson is how you hold your Rubik’s Cube. Remind students to keep their Rubik’s Cubes on their mats to ensure the correct orientation. Many of the slides are animated so what you see in this guide may not appear all at once in the presentation. Please modify your presentation to best meet the needs of your students.

**Slides 3 - 7**

**Holding your Rubik’s Cube.**

Match your Rubik’s Cube to one of the pictures. Focus on the **YELLOW** edges on the **UP (U)** face only (not corners).

Only the Yellow tiles in the positions shown matter.

**HINT:** Have students place their flat palms on the face you want them to turn.

**ACTION 1**

Follow this algorithm.

As with previous algorithms, there are inverses which may be helpful to point out. The first three moves go clockwise and the next three moves go counter-clockwise.

**ACTION 2**

If the **YELLOW** Cross is not formed yet.

REMATCH your Rubik’s Cube to one of the pictures in the ‘Holding your Rubik’s Cube’ section (slide 3) and follow the algorithm again.

If your Rubik’s Cube looks like this, you are ready to move on!

**PRACTICE!**

As you solve the Final Layer, you want to make sure you have not undone the White face or the Middle Layer. If you did, you'll need to go back and fix things.

Make sure you go in order.

Reassure students that it may take a couple of repetitions of the algorithm to achieve the Yellow Cross, depending on how the Rubik’s Cube was initially scrambled.

**Other large cubes can be found below:**


www.youcandothecube.com

©1974 Rubik’s® Used under license Rubik’s Brand Ltd. All rights reserved
Learning to Solve

Solve Final Layer
STEP 1:
Make a Yellow Cross

Solve the Final Layer
STEP 2:
Orient the Corners

- There is only one algorithm.
- The most important part is how you hold the Rubik's Cube before you begin.
- You need to remember this every time you follow the algorithm.
## CONTENT STANDARDS & SKILLS: Solve the Final Layer Step 2: Orient the Corners

<table>
<thead>
<tr>
<th>Grade</th>
<th>Common Core CCSS.MATH.CONTENT</th>
<th>National Council of Teachers of Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>K - 2</td>
<td>K.G.B.4 Analyze and compare two- and three- dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/&quot;corners&quot;) and other attributes (e.g., having sides of equal length)</td>
<td>Algebra • recognize and describe patterns Geometry • use visualization, spatial reasoning and geometric modeling to solve problems</td>
</tr>
<tr>
<td>3 - 5</td>
<td>5.G.B.3 Understand that attributes belonging to a category of two- dimensional figures also belong to all subcategories of that category</td>
<td>Algebra • analyze change in various contexts Geometry • predict and describe the results of sliding, flipping, and turning two-dimensional shapes</td>
</tr>
<tr>
<td>6 - 8</td>
<td>7.G.B.5 Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure 8.G.A.1 Verify experimentally the properties of rotations, reflections, and translations</td>
<td>Algebra • represent and analyze mathematical situations and structures using symbolic language Geometry • create and critique inductive and deductive arguments concerning geometric ideas and relationships</td>
</tr>
</tbody>
</table>
The key to this lesson is how you hold your Rubik’s Cube. Remind students to keep their Rubik’s Cubes on their mats to ensure the correct orientation. Many of the slides are animated so what you see in this guide may not appear all at once in the presentation. Please modify your presentation to best meet the needs of your students.

**Slides 3 - 5**

**HINT:** Have students place their flat palms on the face you want them to turn.

Notice that the focus is on the top corner on the FRONT-LEFT of the UP face.  
**One Yellow Corner:** Hold your Rubik’s Cube so the fish can eat out of your left hand.  
**No Yellow Corners:** Hold your Rubik’s Cube with a Yellow tile on the LEFT face.  
**Two Yellow Corners:** Hold your Rubik’s Cube so that you can put your left thumb on the Yellow tile on the FRONT face.

**ACTION 1**

Follow this algorithm.

Notice the RIGHT (R) face turns in opposite directions every other time. The UP (U) face always turns clockwise.

**ACTION 2**

If you do not have all YELLOW tiles on the UP (U) face you will need to REMATCH (slide 3) and follow the algorithm. (slide 4)  
You may need to do this multiple times. Persevere!  
When your Rubik’s Cube looks like this, you are ready to move on!  
You are almost there!

Orientation is key! Each time the algorithm is completed, the Rubik’s Cube must be turned to match one of the 3 examples. Then, the algorithm is repeated.

Remind students to check that their Rubik’s Cube is still correctly solved up to the Yellow Cross. If it is not, they will need to go back and fix it.
Generally, transformations involve moving an object in a specific way. After the transformation is complete, the result will be congruent to the original object. This may contradict students’ non-math understanding of transformations such as the Transformer series of toys and cartoon characters.

Students may be familiar with line symmetry. Younger students could be challenged to find all the lines of symmetry on a single face. Explore how color influences lines of symmetry. Older students may more easily grasp the concept of rotational symmetry by turning a Rubik's Cube. Challenge students to create other patterns on a face of the Rubik's Cube that have rotational symmetry. This may work well with partners (or with 2 cubes) so that one Rubik's Cube remains in the same position while the second one is turned and compared to the first. Place the Rubik's Cube on a paper plate to turn it easily.

A translation or slide is a movement of an object along a line. This may seem obvious and the point can easily be lost. Have students think about where translations are seen in their world. Fabric and wallpaper with repeating patterns can be examples of translations. What would happen if the creator “stamped” a design without paying attention to whether or not the stamps were placed along a line? (The fabric or wallpaper may look crooked.) Students might try this using stamps or stickers to get a better sense of the concept of translation. Use a ruler as the slide line, the line along which the Rubik’s Cube will move.
In a reflection, the image of the object is flipped over a line. Placing a small mirror or a piece of plexiglass between 2 Rubik’s Cubes may help students see the line of reflection.

Rotations are turns of an object around a point, the center of rotation. Place the Rubik’s Cube on a paper plate or Lazy Susan and mark the center of rotation. Place a finger on the center as the plate is turned.

The plate could be placed on top of a larger piece of paper with an xy axis so that students could see the 90° turns.
Learning to Solve

Solve Final Layer
STEP 3:
Position the Yellow Corners

- In this lesson, there are 2 ways of positioning the Yellow Corners of your Rubik’s Cube before you begin.
- You’ll be looking at the FRONT & BACK views to find the match.
### CONTENT STANDARDS & SKILLS: Solve the Final Layer Step 3: Position the Yellow Corners

<table>
<thead>
<tr>
<th>Grade</th>
<th>Common Core CCSS.MATH.CONTENT</th>
<th>National Council of Teachers of Mathematics</th>
</tr>
</thead>
</table>
| K - 2 | **K.G.B.4** Analyze and compare two- and three- dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/"corners") and other attributes (e.g., having sides of equal length) | **Algebra**  
• recognize and describe patterns  
**Geometry**  
• use visualization, spatial reasoning and geometric modeling to solve problems |
| 3 - 5 | **5.G.B.3** Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category | **Algebra**  
• analyze change in various contexts  
**Geometry**  
• predict and describe the results of sliding, flipping, and turning two-dimensional shapes |
| 6 - 8 | **7.G.B.5** Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure  
**8.G.A.1** Verify experimentally the properties of rotations, reflections, and translations | **Algebra**  
• represent and analyze mathematical situations and structures using symbolic language  
**Geometry**  
• create and critique inductive and deductive arguments concerning geometric ideas and relationships |
The challenge in this lesson is matching the corners to the images before beginning the algorithm. The algorithm is one of the longer ones so using the mat and keeping the Rubik’s Cube on the table is recommended. Many of the slides are animated so what you see in this guide may not appear all at once in the presentation. Please modify your presentation to best meet the needs of your students.

**Slides 3 - 6**

**HINT:** Have students use their mats and keep their Rubik’s Cubes on the mat.

**HINT:** Have students place their flat palms on the face you want them to turn.

Notice that in slides 5 & 6, both the FRONT and BACK views are provided for each Rubik’s Cube. If students are unable to find a match, they should first check to see that their Rubik’s Cube is correctly solved up to this step. If it is not, they will need to go back and fix it. If it is solved correctly up to this step and there is no still match, have them complete the algorithm on the following slides and then rematch their Rubik’s Cube to these pictures.
Solve the Final Layer STEP 3: Position the Yellow Corners

If there is no match to the pictures on slides 5 & 6, then there may not be tail lights on the BACK face. Follow the algorithm once and return to slide 5.

The algorithm is shown over this slide and the next. Because it is a lengthy algorithm, there is an image to check that the students are on the correct path. Encourage students to use the chant (or make up their own chant or story) to help them remember the algorithm.

HINT: Keeping the Rubik's Cube on the table or desk may help students maintain consistent orientation of it which is an important concept as they solve. This is especially important when attempting longer algorithms the first time. The excitement of nearly solving can be dashed when missteps scramble the Rubik's Cube.

Students should be in the habit of checking to see that their Rubik's Cube is correctly solved up to the current step.

www.youcandothecube.com
©1974 Rubik's® Used under license Rubik's Brand Ltd. All rights reserved
Adjacent corners or vertices are connected by the sides of the polygon. **Similarities:** One could make the case that the corners adjacent to A are on the sides of angle A. The intersecting segments that connect the adjacent corners form adjacent (and vertical) angles. **Differences:** Adjacent angles share a common vertex and a common side. (i.e. Angle DAJ and angle JAT are adjacent because they share vertex A and have ray AJ as a common side.) Pairs of adjacent corners on a cube have a common side but do not share a common vertex.

Diagonal vertices are not connected by the sides of the polygon. Vertex A is diagonal to vertex D. B and C are also diagonal vertices. It is important that students begin to develop the understanding that diagonals are not “slanted” lines. A and D will always be diagonal vertices. If the cube in this slide is rotated 45 degrees, the line segment connecting them will be horizontal, not slanted.

One might use this opportunity to explore diagonals in other polygons. Older students may find the pattern in the total number of diagonals in a polygon and generalize that pattern algebraically (#vertices - 2 = #diagonals).

The reported percentage of the world population that can solve a Rubik’s Cube in 2017 varied from 3% to 6%. Some students may be challenged to figure out how many new solvers it would take to increase the percentage 1%.


www.youcandothecube.com
©1974 Rubik’s® Used under license Rubik’s Brand Ltd. All rights reserved
Learning to Solve

Solve Final Layer
STEP 4: Position the Yellow Edges

- how to place the Yellow Edges in the top layer
### CONTENT STANDARDS & SKILLS: Solve the Final Layer Step 4: Position the Yellow Edges

<table>
<thead>
<tr>
<th>Grade</th>
<th>Common Core CCSS.MATH.CONTENT</th>
<th>National Council of Teachers of Mathematics</th>
</tr>
</thead>
</table>
| K - 2 | **K.G.B.4** Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/"corners") and other attributes (e.g., having sides of equal length) | **Algebra** • recognize and describe patterns  
**Geometry** • use visualization, spatial reasoning and geometric modeling to solve problems |
| 3 - 5 | **5.G.B.3** Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category | **Algebra** • analyze change in various contexts  
**Geometry** • predict and describe the results of sliding, flipping, and turning two-dimensional shapes |
| 6 - 8 | **7.G.B.5** Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure  
**8.G.A.1** Verify experimentally the properties of rotations, reflections, and translations | **Algebra** • represent and analyze mathematical situations and structures using symbolic language  
**Geometry** • create and critique inductive and deductive arguments concerning geometric ideas and relationships |
In this final step, there is one algorithm which can be modified depending on whether the Edge piece belongs on the LEFT face or the RIGHT. You may want to direct students to the tip on p. 16 in the solution guide or slide 5 before executing the final algorithm. The algorithm may need to be executed 2 or 3 times to complete the solution.

**Slides 2 - 4**

**HINT:** Have students use their mats and keep their Rubik’s Cubes on the mat.

**HINT:** Have students place their flat palms on the face you want them to turn.

---

If students understand what is happening, they may better remember the algorithm.
- **F2** turns move the row with the unsolved Edge from the top to the bottom layer.
- The **UP** face is turned in the direction of the Edge’s matching Center, which is on the **LEFT** face if making a **U** turn or on the **RIGHT** if making a **U’** turn.
- Then the column of Yellow and the column of White on the **UP** face are moved to the **FRONT** face.

Continuing the algorithm...
- The **F2** turns swap the columns of White and Yellow on the **FRONT** face.
- The **L’ R** turns return the Yellow and White columns to the **UP** face.
- The **U** (or **U’**) turn places the White column into the row closest to the **FRONT** face.
- **F2** puts the White row on the **DOWN** face.

You may need to repeat the entire algorithm, slides 3 & 4, to solve your Rubik’s Cube.
Have students notice that only the U turns change, depending on whether the unsolved Edge belongs on the LEFT face or the RIGHT. The U turn’s arrow points in the direction in which the Edge must move.

The joy of your first solve is exhilarating! Enjoy the moment!

Of course, like any other skill, students will need to practice to internalize the algorithms. There are many content area lessons on our website that may be just the new twist you are looking for on topics you teach!


Or maybe your students are ready for another challenge. Both the Rubik’s Mini and the Rubik’s Master use some of the same skills learned in solving the Rubik’s Cube. They are a good challenge for any age!
CHECK US OUT ONLINE AT:
www.YouCanDoTheCube.com

YOUR NEXT CHALLENGE:

Try the Rubik’s Mini or the Rubik’s Master!

YOU CAN ALSO:

• Borrow from our Cube Lending Program
• Purchase a Rubik’s Cube Education Kit
• Make a Rubik’s Cube Mosaic
• Host a Team Competition

©1974 Rubik’s® Used under licence Rubik’s Brand Ltd. All rights reserved.