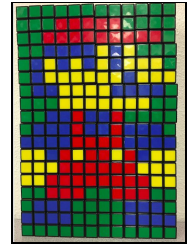


Creating a Rubik's® Cube Mosaic

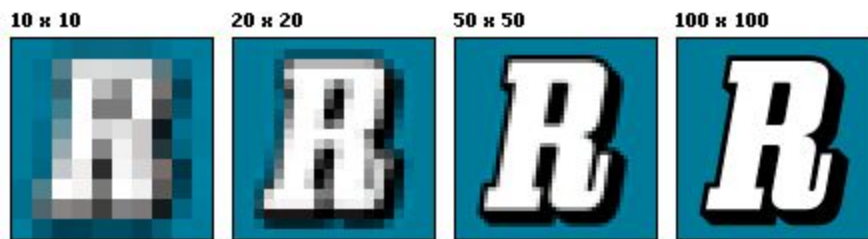
Adding Multi-colored Corners

All digital images are composed of millions of squares or pixels. Students may be familiar with Minecraft or photographs where faces are blurred out. Both of these are examples of enlarging the pixels, resulting in lower resolution. The better the resolution of the image the more pixels per square unit. Creating mosaics using Rubik's® Cubes is a great lesson in resolution and area.



YCDTRC Mosaic Contest
1st place- 24 Cubes
San Luis Middle School

Below is an example of improving resolution as the number of pixels per square unit increases.



https://en.wikipedia.org/wiki/Image_resolution

In this lesson, students will learn how to solve the corners of the upper face of the Rubik's® Cube to a given pattern.

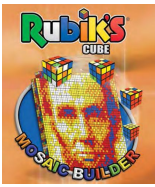
The pages that follow may be individual lessons of 10 - 15 minutes or stations in your classroom. Each student page is followed by a Teacher Notes page.

Standards Addressed in this Lesson:

According to the National Coalition for Core Arts Standards (<http://www.nationalartsstandards.org>), students use critical thinking and problem solving skills in creating and analyzing art. Art is a unique method of communication. More information about art standards can be found at <http://www.nationalartsstandards.org/content/conceptual-framework>.

Common Core Mathematical Practices:

- 1 Make sense of problems and persevere in solving them.
- 2 Reason abstractly and quantitatively.
- 3 Construct viable arguments and critique the reasoning of others.
- 6 Attend to precision
- 7 Look for and make use of structure



Creating a Rubik's® Cube Mosaic

Adding Multi-colored Corners

Materials:

A Rubik's® Cube for each student

Handout for each student or group

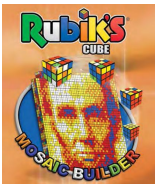
Rubik's® Turn Cards (Memory Game): **Make several copies for each student.**

You may want to cut them out, glue them to index cards, and laminate them.

red, green, blue, yellow, orange colored pencils, markers, or crayons

Background knowledge:

Students should be familiar with the vocabulary of the Rubik's® Cube (edge, corner, center cubes and upper, down, front, back, left & right faces) and how to solve the cross or +. They will come close to mastering how to solve one face of the Rubik's® Cube by the end of the lesson.



Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

Now that you can make the cross or +, it's time to learn about the corner pieces. Start with a solved cube. Hold the cube so that the right face is the blue. Will everyone have the same color on the front face?

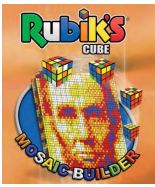
- Find the **red/yellow/blue** corner. Hold the cube so that corner is the upper right of the front face and the right face of the Rubik's® cube is blue.



- You have looked at what happens to the edge pieces when you turn the right side toward you (counterclockwise turn). This time you will look at what happens to the corner piece. Turn the right side once towards you (Ri). Where does the **red/yellow/blue** corner go?

What color of the **red/yellow/blue** corner shows on the front face?

- Turn the right side toward you again. Where is the **blue square** on the **red/yellow/blue** corner now?
- Without turning, predict what turns you should make to move the **red/yellow/blue** corner back to the upper right of the front face. Write the turns here.

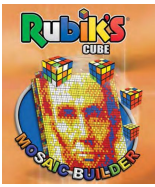


Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

- Follow the directions you wrote. Were you correct?

- Share your directions with a classmate. Are they the same?

- Is there someone in class who has different directions that also work? Why?



Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

Teacher Notes: In this set of instructions, focus eventually changes from top layer to the bottom. Students will learn how to swap the bottom corner with the upper corner directly above it. Encourage students to use the Rubik's® turn cards as they complete the activity. This will make it easier to "undo" their steps at the end of the lesson.

Now that you can make the cross or +, it's time to learn about the corner pieces. Start with a solved cube. Hold the cube so that the blue face is the right face. Will everyone have the same color on the front face? Since the color of the upper face was not specified, some students will have yellow on the front, some may have white.

- Find the **red/yellow/blue** corner. Hold the cube so that corner is the upper right of the front face and the right face of the Rubik's® Cube is blue. Now, everyone should have yellow as the front face.



- You have looked at what happens to the edge pieces when you turn the right side toward you (counterclockwise turn). This time you will look at what happens to the corner piece. Turn the right side once towards you (Ri). Where does the **red/yellow/blue** corner go? Lower right corner of the front face

What color of the **red/yellow/blue** corner shows on the front face? Red. You may want to ask about the other 2 sides of the corner so that students notice that the blue square remains on the blue face.

- Turn the right side toward you again. Where is the **blue square** on the **red/yellow/blue** corner now? The blue square remains on the blue face but now it is in the lower back corner. You may want to ask students where the red and yellow squares are.
- Without turning, predict what turns you should make to move the **red/yellow/blue** corner back to the upper right of the front face. Write the turns here. Either turn the right face away from you twice



thus "undoing" what you have done or turn the right face

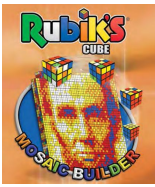


toward you twice thus turning the right side 360°.



This might be a good place to review the inverted notation. Notice the color coding - teal for clockwise turns, blue for the inverted or counterclockwise turns. (Imagine you are facing the Right side.)





Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

- Follow the directions you wrote. Were you correct?

You may want to give students a set of Rubik's® turn cards so that they can make a sequence of turns with the cards, check to see if they work, and then record their results. Answers will vary. Encourage students to find the most efficient method, one of the 2 described above.

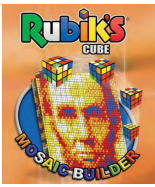
- Share your directions with a classmate. Are they the same?

The directions may differ. Encourage students to explain to one another why differing methods work or to brainstorm to find another method that will work.

- Is there someone in class who has different directions that also work?
Why?

Lots of good explanations are possible here. The student could be working backwards and having to do the opposite turn, again an opportunity to talk about the inverted notation in the Rubik's® Cube Solution Guide. The student could talk about turning half a circle, two halves make a whole so you'd wind up in the starting position, maybe making a ferris wheel analogy. You could have students act out the turns with their bodies.

Have students “undo” their directions so that the Rubik's® Cube is returned to a solved state before beginning the next page.



Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

Hold your solved cube so the upper face is red and the right face is blue.

- Find the **yellow/blue/orange** corner. Hold the cube so that corner is the lower right of the front face and the right face of the Rubik's® cube is blue.



- Without turning the cube yet, predict where the **blue square** on the **yellow/blue/orange** corner will be if you turn the down face again one turn to the left.

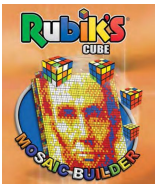
- Now make that one turn. Were you correct?
- Turn the down face twice to the right (clockwise or D), as if you are closing a jar. Where is the **blue square** on the **yellow/blue/orange** corner now?
- Put the **yellow/blue/orange** corner back where it was when you started. What turn or turns did you make?
- Where will the **yellow/blue/orange** corner be if you follow these directions?



then



What color of the **yellow/blue/orange** corner is on the front face? How has the corner cube changed?

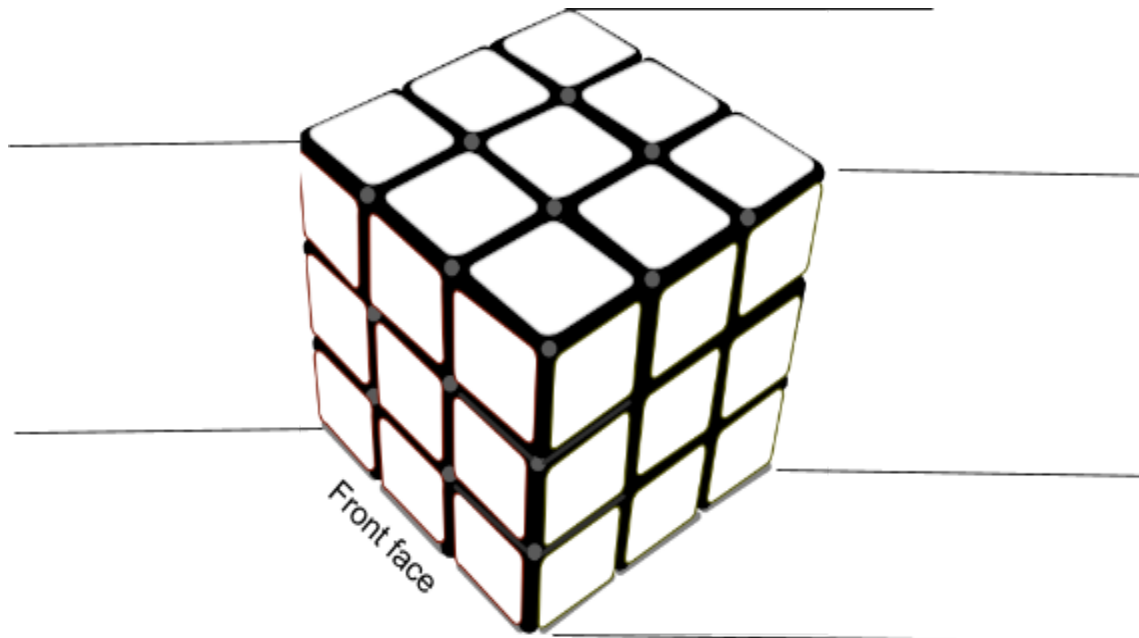


Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

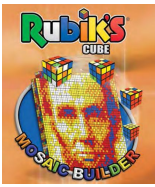
- Where does the **red/yellow/blue** corner go?

Looking at the **red/yellow/blue** corner, what color is the square that shows on the front face?

- Which of the other corner pieces moved?
- Where did they wind up? Label each corner with its colors. Color the squares of the corners you can see.



- Describe to a partner how the colors of the **edge pieces** changed places. Why did the colors change places?

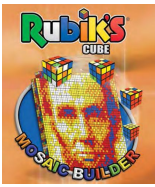


Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

- Predict which turns should you make to put the **yellow/blue/orange** corner on the top layer of your Rubik's® Cube. Record your turns here.

- Follow the directions you wrote. What color is the square on the upper face?

- Record the steps you would use to return the Rubik's® Cube to the solved state. Then follow the steps you wrote.



Creating a Rubik's® Cube Mosaic

Adding Multi-colored Corners

Teacher Notes: Encourage students to use the Rubik's® turn cards as they complete the activity. This will make it easier to “undo” their steps at the end of the lesson.

Hold your solved cube so the upper face is red and the right face is blue.

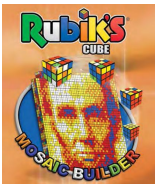
- Find the **yellow/blue/orange** corner. Hold the cube so that corner is the lower right of the front face and the right face of the Rubik's® cube is blue. **The yellow/blue/orange corner will be on lower right of the front face. The upper face will be red.**



- Without turning the cube yet, predict where the **blue square** on the **yellow/blue/orange** corner will be if you turn the down face again one turn to the left. **The blue square will now be on the left side of the front face.**
- Now make that one turn. Were you correct? **Have students help one another to get the blue square in the correct position.**
- Turn the down face twice to the right (clockwise or D), as if you are closing a jar. Where is the **blue square** on the **yellow/blue/orange** corner now? **The blue square will be on the back face, left side of the bottom layer if you were looking at the back face.**
- Put the **yellow/blue/orange** corner back where it was when you started. What turn or turns did you make? **Turn the down layer one turn to the left, Di.**
- Where will the **yellow/blue/orange** corner be if you follow these directions? **The lower right of the front (see below)**

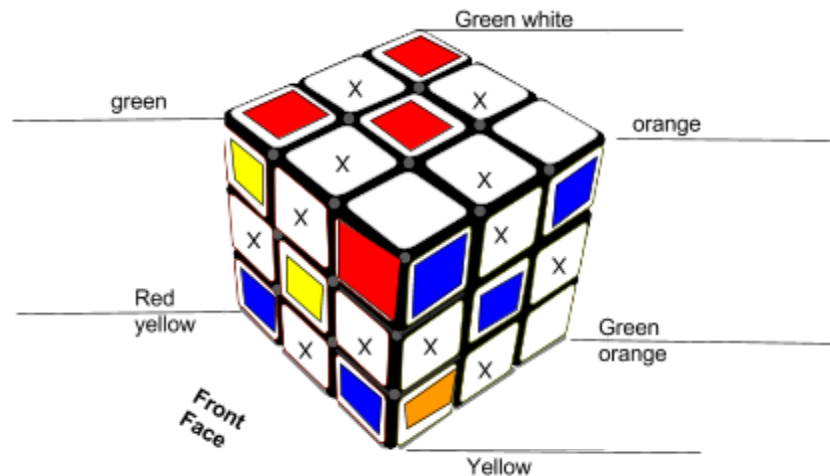


What color of the **yellow/blue/orange** corner is on the front face? **Blue.** How has the corner cube changed? **Students should notice that it is the lower right corner instead of the lower left corner. The yellow square is on the down face instead of the lateral face. The orange square is on the lateral face instead of the down face. The corner has “turned” or “flipped.”**



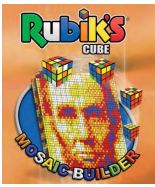
Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

- Where does the **red/yellow/blue** corner go? **It is on the lower left front face.** What color is the square that shows on the front face? **Blue.** Perhaps students will notice that this corner is flipped as well.
- Which of the other corner pieces moved? **The two corners that did not move are the red/green/white corner and the red/green/yellow corner because they are both on the left side of the upper face.** Have the students describe how the other corners moved. **The orange/green/yellow corner and the orange/green/white did not flip because they only rotated on their bottom layer (Di).**
- Where did they wind up? Label each corner with its colors. **Color the squares of the corners you can see. The center tiles have been colored to help orient the cube. You may want students to do this as well. The visible edge pieces are ignored. You may want student to X them out.**

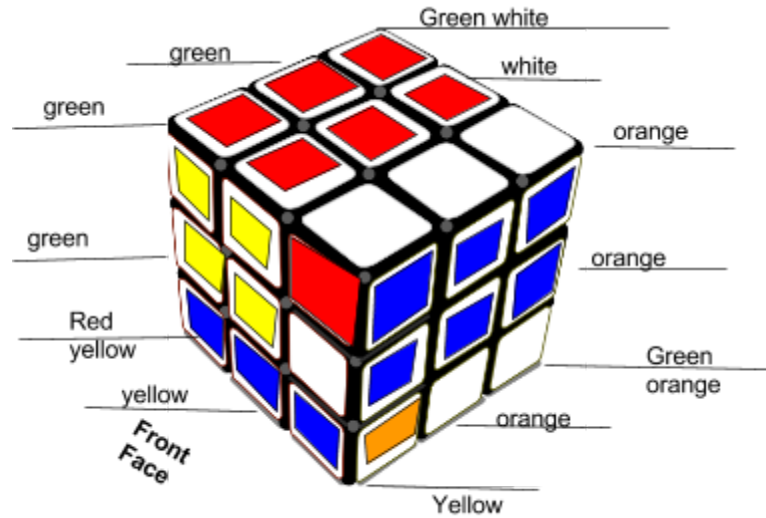


Source of image: <http://www.clker.com/clipart-rubiks-cube-white.html>

- Describe to a partner how the colors of the **edge pieces** changed places. Why did the colors change places? **You may want to have students color the edge pieces so that they can see the change. (see next page)** Have students pair up so that one student has a solved cube and the other has the cube after the two turns have been made so that they can more easily compare how the edges have moved. In general, one move changes the location; two moves, in different directions, flips the edge.



Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners



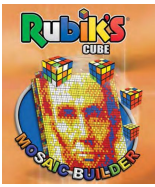
- Predict which turns should you make to put the **yellow/blue/orange** corner on the top layer of your Rubik's® Cube. Record your turns here.



- Follow the directions you wrote. What color is the square on the upper face? **Blue.**
- Record the steps you use to return the Rubik's® Cube to the solved state.



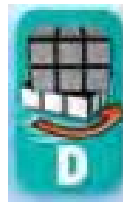
Undoing the turns that were made



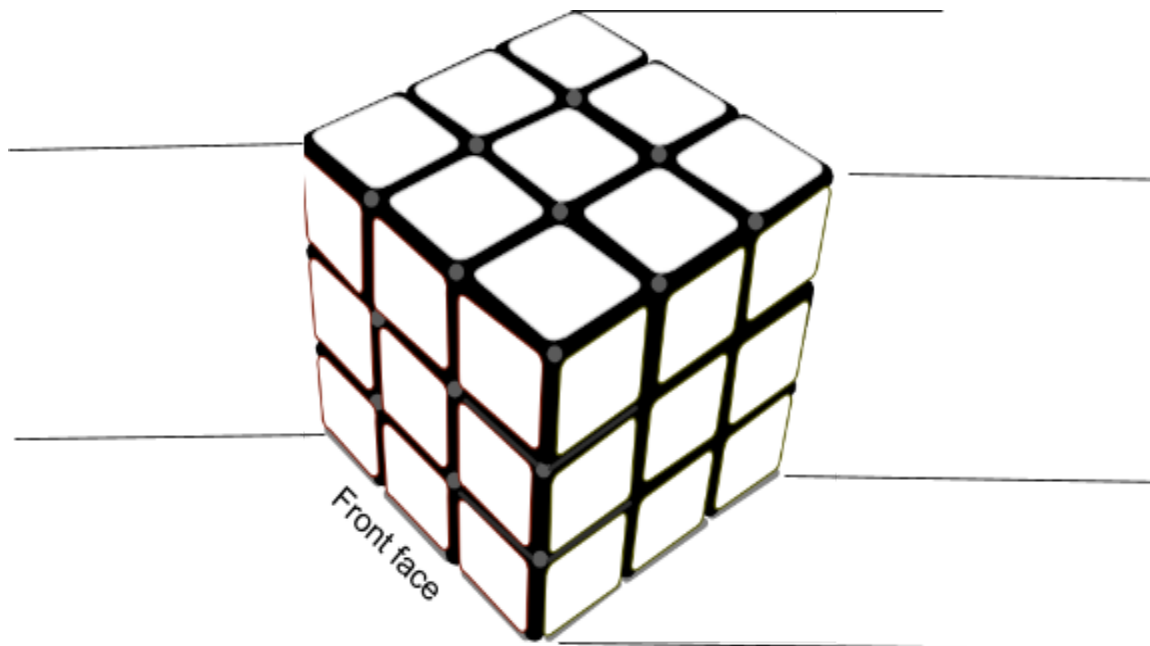
Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

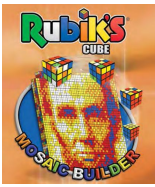
Hold your solved cube so the upper face is red and the right face is blue.

- Make these turns. Predict where will the **red/yellow/blue** corner be when you are done.



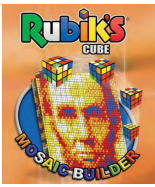
- Color the corners of the cube below. Write the colors of the squares you can't see on the lines.





Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

- Find the **green/yellow/orange** corner piece. Find the **green/yellow/orange** corner piece. What **corner** is directly above it?
- Record the turns you will need to swap those corner pieces.
- Where is the **yellow square** of the **green/yellow/orange** corner piece now?



Creating a Rubik's® Cube Mosaic

Adding Multi-colored Corners

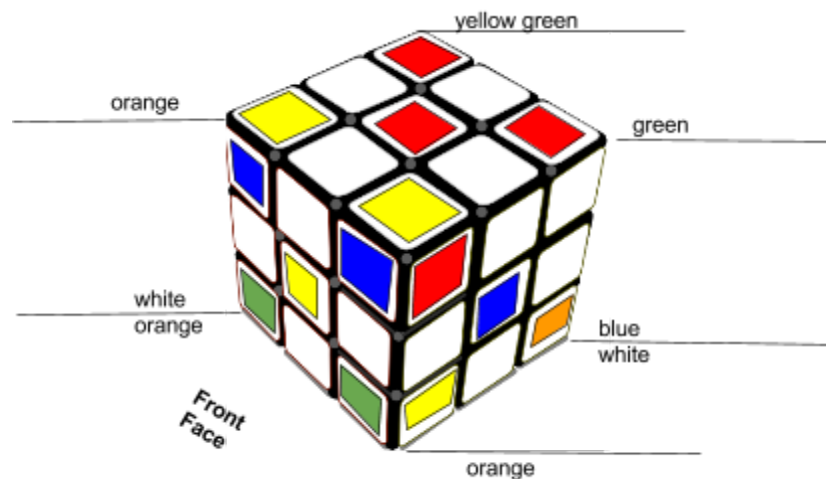
Teacher Notes: Students will practice swapping a bottom corner for the corner directly above it. Encourage students to use the Rubik's® turn cards as they complete the activity. This will make it easier to "undo" their steps at the end of the lesson.

Hold your solved cube so the upper face is red and the right face is blue.

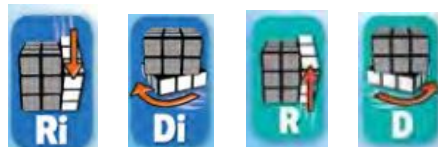
- Make these turns. Predict where will the **red/yellow/blue** corner be when you are done. It will be in its original position. However, the yellow square will be on the top face; blue, on the front; red, on the right.



- Color the corners of the new cube pattern below. Write the colors of the squares you can't see on the lines.

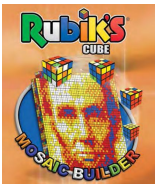


- Find the **green/yellow/orange** corner piece. What **corner** is directly above it? **yellow/blue/red**
- Record the turns you will need to swap those corner pieces.



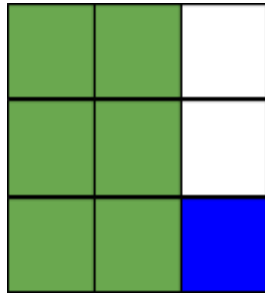
- Where is the yellow square of the **green/yellow/orange** corner piece now? **On the upper face**

Have students "undo" all the directions so that the Rubik's® Cube is returned to a solved state.



Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

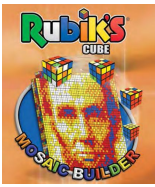
Start with a solved Rubik's® Cube. You are going to put this pattern on the upper face of the cube.



What color should the upper face be?

What color should the right face be?

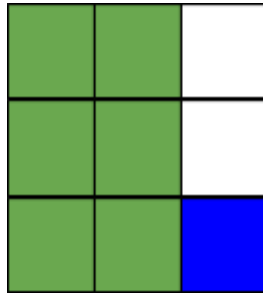
What turns will you need to make to create this design on the upper face of your cube? Record your turns here.



Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

Teacher Notes : There are other solutions. This one follows the directions from the YCDTRC Solution Guide, which, along with the YCDTRC Beginners Mosaic Guide, is the source for the lessons in this unit. Encourage students to use the Rubik's® turn cards as they complete the activity. This will make it easier to "undo" their steps at the end of the lesson.

Start with a solved Rubik's® Cube. You are going to put this pattern on the upper face of the cube.



What color should the upper face be?

Since the center square is green, the upper face must be green.

What color should the right face be?

Since the right edge piece is white, hold the cube so the white face is white.

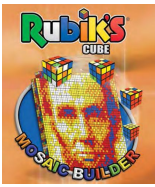
What turns will you need to make to create this design on the upper face of your cube? Record your turns here.

Always begin with the edge pieces. Follow the steps to flip the edge piece.



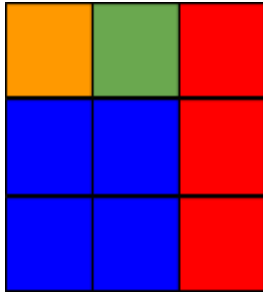
The lower right corner on the upper face is now blue so you have created the desired pattern.

Have students "undo" their directions so that the Rubik's® Cube is returned to a solved state.



Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

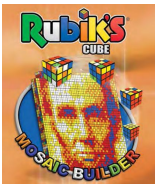
Start with a solved Rubik's® Cube. You are going to put this pattern on the upper face of the cube.



What color should the upper face be?

What color should the right face be?

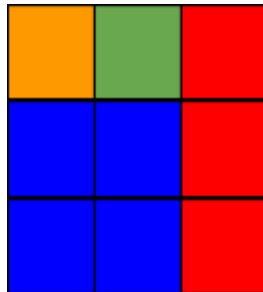
What turns will you need to make to create this design on the upper face of your cube? Record your turns here.



Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

Teacher Notes : There are other solutions. This one follows the directions from the YCDTRC Solution Guide, which, along with the YCDTRC Beginners Mosaic Guide, is the source for the lessons in this unit. Encourage students to use the Rubik's® turn cards as they complete the activity. This will make it easier to "undo" their steps at the end of the lesson.

Start with a solved Rubik's® Cube. You are going to put this pattern on the upper face of the cube.



What color should the upper face be? **Blue** because the center square is blue

What color should the right face be? **Since we start with the edge pieces, the possibilities for the right side are either green or red, the two colors which are not already edge pieces. Green is the down face of the cube when blue is the upper face. So, the right face must be red.**

What turns will you need to make to create this design on the upper face of your cube? Record your turns here. **Here is one possibility:**



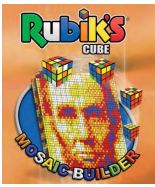
will move the green/yellow edge to the upper face.



will flip the blue/red edge so that the red square is on the upper face.

Now, you need to flip the corners.

Turn the down face 2 turns counterclockwise to position the yellow/red/blue corner under the blue/yellow/orange corner. Notice that the red square will



Creating a Rubik's® Cube Mosaic Adding Multi-colored Corners

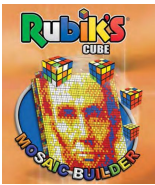
be on the right face of the cube. Now that the correct corner is in position, follow the steps for flipping the corners.



Keeping the upper face blue, rotate the entire cube so that the right face is orange (center square). Notice that the yellow/orange/green corner is below the green/yellow/red corner. The orange square which you want on the upper face is currently on the right face. Now that the correct corner is in position, follow the steps for flipping the corners.



Have students “undo” their directions so that the Rubik's® Cube is returned to a solved state.



Creating a Rubik's® Cube Mosaic

Adding Multi-colored Corners

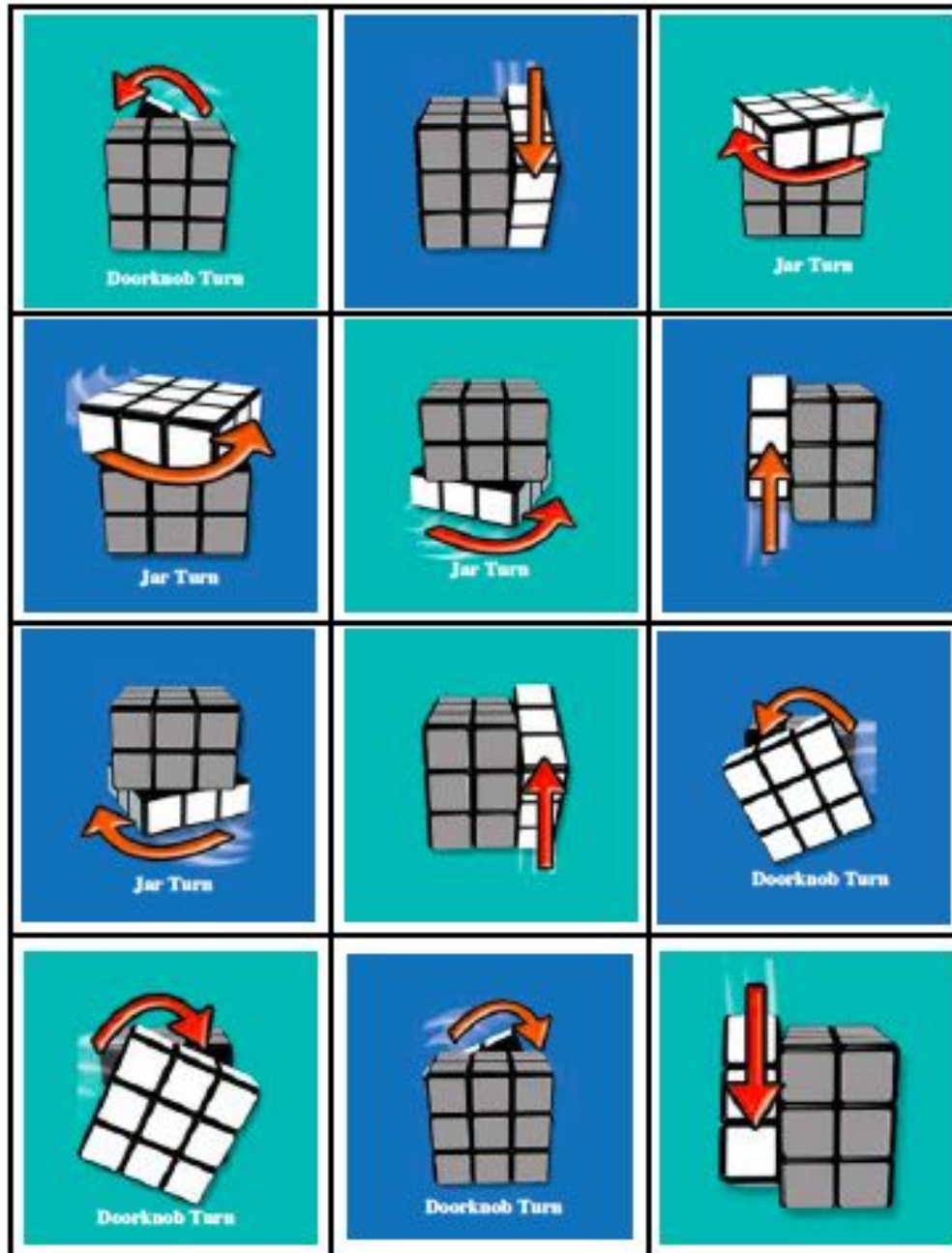
Review Lesson

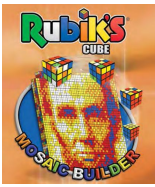
I CAN Do The Cube

MEMORY GAME

- Cut out each playing card.
- Place them upside down.
- Take turns trying to match the image with the correct letter representation.

Rubik's® Turn Cards





Creating a Rubik's® Cube Mosaic

Adding Multi-colored Corners

I CAN Do The Cube

Review Lesson

R

Ri

L

Li

B

Bi

D

Di

F

Fi

U

Ui