EDUCATOR Guide





Beyond Rubik's Cube celebrates the innovations and insights inspired by 40 years of playing with the world's most popular puzzle. The exhibition has three organizing themes: **Invent, Play** and **Inspire**. Students can explore the principles of math and design underlying the Cube's invention; discover how playing with a brainteaser like the Cube calls on different components of human intelligence; and consider how the Cube has inspired artists, engineers, and other creative innovators.





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How to Use this Guide

0

Standards

Next Generation Science Standards: CC.1 Patterns, CC.6 Structure and Function, ETS1.1-4, SEP.1-5, STS.2

Common Core State Standards for Mathematics: MP.1, MP.2, MP.7, K-5.G

International Society for Technology in Education – Student Standards: 1.b, 1.c, 2.a, 4.d

This educator guide provides an overview and background for the content presented in **Beyond Rubik's Cube**. We encourage you to explore the exhibition yourself before visiting with students.

Visit **beyondrubikscube.com** to learn more about the exhibition and its available educational programming. This guide includes guiding questions to focus student learning and enhance engagement. The answers provided are brief and students may respond with additional information found in the exhibition.





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Where did

Rubik's Cube

come from?

As a young professor of design, Hungarian Ernő Rubik developed models for explaining three-dimensional geometry and spatial transformation. He wanted a teaching tool to help his students visualize these concepts. Through the process of engineering design, Professor Rubik imagined potential solutions, created models to test out his ideas, and then improved on his design after observing what worked and what could be better. As he experimented with his prototypes, he discovered that returning the model to its original form was actually much harder than scrambling it, and so the puzzle was born. Students can observe Rubik's prototypes and engage in some design experimentation themselves with materials similar to those that Rubik used in his early models. Don't miss **Cube Prototypes** and **Cube Origins**.





Why has Rubik's Cube inspired so many divergent uses beyond the original puzzle?

The Cube holds multiple meanings for people. Mathematicians are fascinated by its more than 43-quintillion permutations and its intricate solution algorithms. In fact, Rubik's Cube inspired a resurgence of a branch of mathematics known as group theory that studies these qualities. Computer scientists and roboticists use algorithms to develop increasingly complex programs and impressively fast and dexterous robots, similar to the way in which algorithms are used to solve the Cube.

As a design object, the Cube is a muse for artists. From its colors and shape to its ability to change while staying the same, the Cube offers musicians and poets a tool to explore similar concepts in different mediums. While its six basic colors appear limiting, pixelated murals formed from multiple cubes prove otherwise, relying on our eyes to blend colors that the artist cannot.

The reputation of Rubik's Cube as nearly impossible to solve helped immortalize it in the media as a symbol of challenging problems. After exploring some of the inspired uses of Rubik's Cube over the past 40 years, how can your students expand on this cultural legacy? Don't miss **Platonic Solids**, **Twisty Puzzles**, **Haikube**, **Collaborative Mosaic**, **Cube Symphony** and **Cube Culture**.





What's special about solving Rubik's Cube?



Rubik's Cube is language-less. The rules to solve it are built into the toy—twisting the faces along three axes. While these rules are simple to discover, actually solving the puzzle from one of its 43-quintillion possible configurations is much more challenging. To solve Rubik's Cube, we need to use spatial reasoning, pattern recognition, and short-term memory skills. Several procedures, or algorithms, have been developed to solve the Cube. This simplification of a task into a logical step-by-step process is the core of computer programming as well. Don't miss **Solve Bar, Brain Moves** and **Robot Command**.



3



Beyond a puzzle to be solved, the Cube is a Platonic solid and a tessellation with nine smaller squares on each face, geometric properties that can be explored mathematically and artistically. The internal mechanism that allows all six of the Cube's faces to rotate is a result of a long design process. Your students can see many of Rubik's prototypes in the gallery, and experiment with similar materials. Don't miss **Giant Cube, Cube Origins** and **Cube Prototypes**.



What's special about Rubik's Cube's engineering and design?





5 Why is play important?





Play, and specifically puzzle-solving, is a way for individuals and groups to develop and practice problem-solving. A variety of cognitive skills are developed through play, each requiring different brain functions. When playing with Rubik's Cube, multiple portions of the brain must interact to work toward a solution. Playing with Rubik's Cube has inspired many people in science, math, engineering, and the arts. Some even say that the curiosity, imagination, reasoning, and persistence required to solve the Cube has led to innovations across many fields! Don't miss Color Match, Brain Moves, Cube Man, Faces of the Cube, Cube Symphony and Cube Culture.





Think of a puzzle as a problem that is fun to solve and has one correct solution. Under this definition, puzzles are a form of play, but they are different from toys and games. They also differ from everyday problems that may not be fun to solve and often have many possible solutions. Don't miss **Puzzle Bar**.



An algorithm is a set of rules or processes to follow in a problemsolving operation. They are commonly used in mathematics and computer science, but algorithms are also used to solve the Cube. Using an algorithm involves breaking down a problem into a series of repeatable steps. Don't miss **Robot Command** and **Solve Bar**.

What is an algorithm and how is it related to Rubik's Cube?





