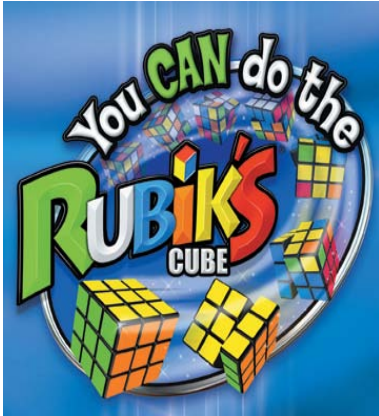


STEM Lesson-Rubik's Cube-Middle School



STEM Alignment

- Science
 - NS.5-8.1 Science as Inquiry
 - As a result of activities in grades 5-8, all students should develop
 - Abilities necessary to do scientific inquiries
 - Understandings about scientific inquiry
- Technology
 - Extension Activities
 - ISTE NETS ~ NT. K-12.3 Technology Productivity Tools
 - Students use technology tools to enhance learning, increase productivity, and promote learning
- Engineering
 - Students will apply scientific, mathematic, and practical knowledge to design and build a structure.
- Mathematics
 - Lesson aligned to Common Core Standards (see below)

Common Core Standards

GRADE 6

6.RP: Ratios and Proportional Relationships

Understand ratio concepts and use ratio reasoning to solve problems.

1. Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.
3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

GRADE 6

6.G: Geometry

Solve real-world and mathematical problems involving area, surface area, and volume.

4. Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

Reading Standards for Literacy in Science and Technical Subjects 6-12

Key Ideas and Details (Grades 6-8 students)

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure (Grades 6-8 students)

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

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National Standards

- Instructional programs for Algebra grades 6th-8th should enable all students to:
- Precisely describe, classify, and understand relationships among types of two- and three-dimensional objects using their defining properties;

21st Century Skills

- Learning and Innovation Skills
 - Critical Thinking and Problem Solving
 - Exercising sound reasoning in understanding
 - Understanding the interconnections among systems
 - Identifying and asking significant questions that clarify various points of view and lead to better solutions
 - Framing, analyzing and synthesizing information in order to solve problems and answer questions
 - Creativity and Innovation
 - Acting on creative ideas to make a tangible and useful contribution to the domain in which the innovation occurs
- Life and Career Skills
 - Initiative & Self-Direction
 - Defining, prioritizing and completing tasks without direct oversight
 - Utilizing time efficiently and managing workload
 - Leadership & Responsibility
 - Using interpersonal and problem-solving skills to influence and guide others toward a goal



Objective

- In this activity, students will learn the names of the different pieces of the Rubik's Cube, learn the PBL (Problem-Based Learning) approach to solving problems and act as engineers, using science and math skills, to design a Rubik's Cube model.



Materials

Rubik's Cube (one for each group to look at and possibly take apart)
Construction paper
White tag board
Clay or play dough in different colors (optional)
Scissors
Markers (red, blue, green, yellow, orange)
Glue Sticks
Bottles of Glue
Tape
Paper clips
Any other art supplies available (students may come up with creative ways to use them)
Computers w/PowerPoint and internet capabilities

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Procedure

- Begin by holding up a Rubik's Cube and asking students if they know what it is.
- Ask them if they know how it works, then take the cube apart in front of them.
- As you put the cube back together again, show students the small pieces that make up the larger Rubik's Cube.
- Go over the name of each piece (this is how each cube is identified in the solution guide). Write on board in front of students:
 - **Edge Pieces:** Pieces with two colors - There are 12 Edge Pieces in each cube, located in the middle rows.
 - **Corner Pieces:** Pieces with three colors – There are 8 Corner Pieces in each cube, located at the corners.
 - **Center Pieces:** Pieces with one color – There are 6 Center Pieces in each cube, located in the center of each side. (It's important to remember when solving the cube, center pieces do not move and they represent the color of the side.)
- Ask the student how many pieces (smaller cubes) make up the Rubik's Cube. (26)
- Remind students that Center Piece colors are always opposite each other. (Show them on the cube.)
 - White is opposite Yellow
 - Orange is opposite Red
 - Green is opposite Blue
- Tell the students in this activity they will play the role of engineer. Ask students if they know what engineers do. (Engineering is the practical application of science and math to solve problems.)
- Give students the following problem:
 - *Your job is to recreate a miniature, pocket-size Rubik's Cube. You will work in groups of three to brainstorm and develop a 3x3x3 Rubik's Cube that is much smaller than the standard cube (students should measure the standard 3x3x3 cube). You must present a prototype to the class via PowerPoint - your presentation must include a scale model of the cube (complete with measurements). You will have five class periods to complete this activity and you should complete a journal entry for each day's activities. Upload pictures of the prototype into the PowerPoint presentation.*
- Teach students the PBL (Problem-Based Learning) approach (*learning this approach is just as important as solving the problem*):
 1. Explore the issues:
 - Your teacher introduces an "ill-structured" problem to you.
 - Discuss the problem statement and list its significant parts.
 - You may feel that you don't know enough to solve the problem but that is the challenge!
 - You will have to gather information and learn new concepts, principles, or skills as you engage in the problem-solving process.
 2. List "What do we know?"
 - What do you know to solve the problem?
 - This includes both what you actually know and what strengths and capabilities each team member has.
 - Consider or note everyone's input, no matter how strange it may appear: it could hold a possibility!

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3. Develop, and write out, the problem statement in your own words:
 - A problem statement should come from your/the group's analysis of what you know, and what you will need to know to solve it. You will need:
 - ✓ a written statement
 - ✓ the agreement of your group on the statement
 - ✓ feedback on this statement from your instructor
 4. List out possible solutions.
 - List them all, then order them from strongest to weakest.
 - Choose the best one, or most likely to succeed.
 5. List actions to be taken with a timeline.
 - What do we have to know and do to solve the problem?
 - How do we rank these possibilities?
 - How do these relate to our list of solutions?
 - Do we agree?
 6. List "What do we need to know?"
 - Research the knowledge and data via the Internet that will support your solution.
 - You will need to find information to fill in missing gaps.
 - Discuss possible resources.
 - ✓ Experts, books, web sites, etc.
 - Assign and schedule research tasks, especially deadlines.
- Remind students they must develop the ability to conduct investigations using prior knowledge and experiences.
 - Do not give students too many details on *HOW* to build the cube. This is part of the challenge and problem-based learning process! However, keep the following hints in mind to guide the students while acting as facilitator to each group of problem-solvers.
 - Remember the cube is made up of 26 pieces (smaller cubes). Students may want to use an additional small cube in the center to anchor the 26 cubes.
 - Review/introduce hexominoe nets and show an example of a cube built using nets (see attached). Students should be encouraged to create their own and NOT use the pattern.
 - Higher level students could research origami and create cubes using this method.
 - Students should build and color (markers work well) 12 Edge Pieces, 8 Corner Pieces, and 6 Center Pieces.
 - The pieces can be glued together (unlike the real Rubik's Cube), but special attention must be paid to where each side is placed (White is opposite Yellow, and so on...).



Notes to Teacher

- This lesson will take approximately six 45-minute class periods.
- You can make multiple copies of the cube pattern so the students just cut each of them out or you can just give them one pattern made from tag board and ask them to trace the others they will need on another sheet of paper. If students are more advanced, do not supply the cube pattern and ask them to create their own hexominoe nets to create the cube.
- Supply tape in case the glue isn't holding the cubes together well.
- This lesson follows the problem-based learning approach. It is important that the teacher act as *facilitator* throughout the learning process.

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Differentiated Instruction Ideas

- To challenge your students, consider asking them to color each of the smaller cubes before they put them together to make the larger, "Rubik's Cube".
- You may want to require a minimum of three different materials to be used in the construction of the cube. Tape and glue do not count.
- Give bonus points to students that are able to construct a cube that has one moveable face!



Extension Activities ~ Technology

- Direct students to www.YouCanDoTheCube.com and ask them to click "Join" at the top of the page. After students have joined the community, guide them in editing their profile.
 - Click "Edit Profile" at the top of the page.
 - Students will be asked to upload a photo, write a brief biography, and fill in boxes under "Common Profile Options".
- Direct students to www.YouCanDoTheCube.com after they have joined the Rubik's Cube community (see above) and invite them to navigate the website.
 - Click "Secrets Unlocked" at the top of the page.
 - Students may click on "Solution Guide" to view all six steps to solve the Rubik's Cube.
 - Students may click on "Rubik's Cube Starts" to view celebrities having fun with the Rubik's Cube.
 - Students may click on "Teach Friends and Win" to learn how to earn points and get free stuff by teaching friends to solve the Rubik's Cube.
- Direct students to www.YouTube.com/user/RubiksCubeSolution and watch several videos. Invite students to comment on their favorite videos.
 - Under "All Comments" at the bottom of the page, write your response to the video in the given text box.
 - Click "Post" under the text box to post your comment.
- Direct students to www.YouTube.com/user/RubiksCubeSolution and invite them to upload their own video involving the Rubik's Cube!
 - Click "Upload" then select "Upload video" or "Record from Webcam".
 - Choose location of video (if uploading) or follow directions on screen for recording directly from a webcam.
 - Give your video a title and briefly describe your video in the given text box.
- Direct students to <http://twitter.com/rubiksonline> and invite them to follow Rubik's Online!
 - Students must sign in or create a Twitter account to "follow" (get short, timely messages from Rubik's) Rubik's Online.
 - Once signed in, students just click "follow" and they're instantly connected to the Rubik's Cube 24/7!
- Invite students to view You Can Do the Cube's Facebook fan page at home by going to www.facebook.com/YouCanDoTheRubiksCube?v=wall
 - Suggest they read several posts on the Wall, peruse Photos, and even join Discussions!
 - Wall, Info, Photos, Discussions, Events, and YouTube are all tabs at the top of Rubik's Cube's Facebook fan page. Click on each tab to view its contents.

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Cube Pattern

