STEM Lesson- Build a Rubik's Cube

Middle School

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;

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

State Standards

CCSS.MATH.CONTENT.6 RPA.1&3

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.

CCSS.MATH.CONTENT.6.G.A.4

Geometry

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

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.

CCSS.ELA-LITERACY.RST.6-8.3&4

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.

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

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 (or other digital presentation tool) and Internet capabilities

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.

Notes to Teacher

- This lesson will take approximately three 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.
- 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.

Procedure

1. Begin by holding up a Rubik's Cube and asking students if they know what it is.
2. Ask them if they know how it works, then take the cube apart in front of them. *(OPTIONAL- this lesson works without taking a Rubik's Cube apart, and you should not take one apart if it is from the You Can Do the Rubik's Cube Lending Library.)*
3. As you put the cube back together again, show students the small pieces that make up the larger Rubik's Cube.
4. 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 of the 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 face. (It's important to remember when solving the cube, center pieces do not move and they represent the color of the face.)
5. Ask the student how many pieces (smaller cubes) make up the Rubik's Cube. (26)
6. 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
7. 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.)
8. 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 a few 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. (Some teachers have allowed up to 5 days for this activity, any digital presentation can be used in place of PowerPoint.)
9. Teach students the PBL (Problem-Based Learning) approach (learning this approach is just as important as solving the problem):
   - 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.

- 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!
- 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
- List out possible solutions.
  - ⇒ List them all, then order them from strongest to weakest.
  - ⇒ Choose the best one, or most likely to succeed.
- 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?
- 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.

10. Remind students they must develop the ability to conduct investigations using prior knowledge and experiences.
11. 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…).

Cube Pattern