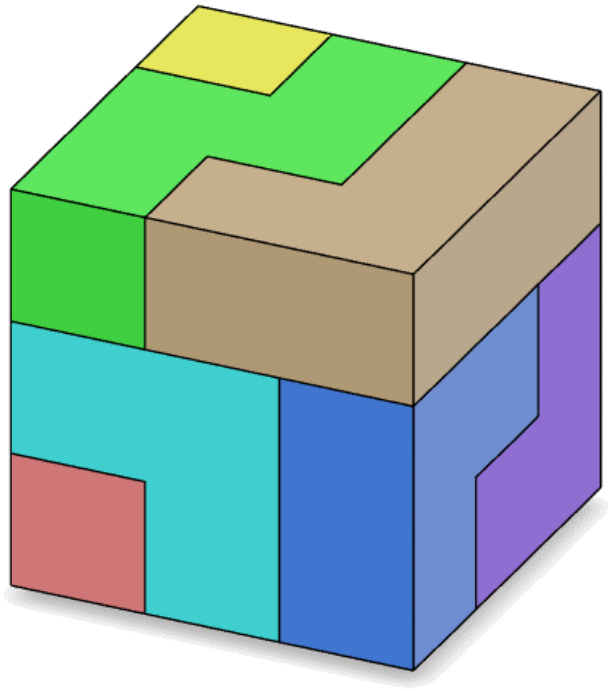
DESIGN PROJECTS



PUZZLE CUBE

GRADE LEVEL

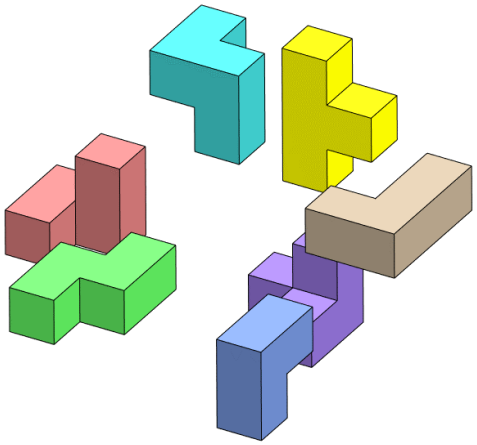
Grades 6–8

MODELING TIME

5-10 hours

MATERIALS

- CAD software (SOLIDWORKS Design or xDesign)
- 3D printer with filament (Approximately 100g) or wood pieces for fabrication
- Sandpaper, file, or deburring tools
- Adhesive (optional)
- Graph paper (for initial sketches)



DESIGN OBJECTIVES

- Cube to be 60x60x60mm
- Each side to be broken into 3 equal 20mm segments
- Cube must consist of at least 5 pieces

DESCRIPTION

Students will design and build a puzzle that can be broken into several geometric shapes. They will focus on geometrical relationships and tolerances while learning about CAD and manufacturing techniques like 3D printing or woodworking.

EDUCATIONAL CONCEPTS

MATHEMATICS

- Calculating volume and surface area
- Measuring and understanding tolerances

ENGINEERING PRINCIPLES

- Understanding material properties
- Exploring snug fits and interlocking mechanics

TECHNOLOGY

- Using CAD software to model components
- 3D printing or manual cutting techniques

CREATIVITY AND PROBLEM-SOLVING

- Designing a unique puzzle that challenges spatial reasoning

HISTORY

Puzzle cubes are inspired by traditional dissection puzzles, which have been used for centuries to teach geometry and problem-solving. Modern versions, like the Soma cube invented in 1933 by Piet Hein, focus on mathematical and spatial challenges.

LESSON TOPICS

Phase 1: Brainstorming and Planning

- Think about the end goal: A cube made of interlocking pieces.
- Sketch out different configurations for how the pieces might fit.
- Each piece should occupy specific cubic units that can interlock with others.
- Decide on the number of pieces (e.g., 5–7 pieces) and whether they are symmetrical or irregular.

Phase 2: CAD Modeling

- **Sketching**
  - Begin with a 2D sketch of a single puzzle piece on a CAD software plane.
  - Add extrusions to turn the 2D sketch into a 3D model.
- **Assembly Simulation:** Test how pieces will fit together virtually using assembly mates.
- **Tolerance Adjustments:** Include small gaps (e.g., 0.2 mm) for 3D printed parts to ensure snug fits without being too tight.

Phase 3: Prototyping

- **3D Printing/Woodworking:** Print or cut each piece, ensuring dimensional accuracy.
- **Testing:** Assemble the pieces to confirm they fit and stay together. Identify areas needing refinement (e.g., oversized parts, loose fits).
- **Iterating:** Modify CAD designs based on testing feedback and remake as needed.

Phase 4: Final Assembly and Presentation

- Refine pieces with sandpaper or files.
- Paint or decorate pieces for a polished look.
- Present the finished puzzle to the class, including the design process and challenges faced.

DISCUSSION STARTERS

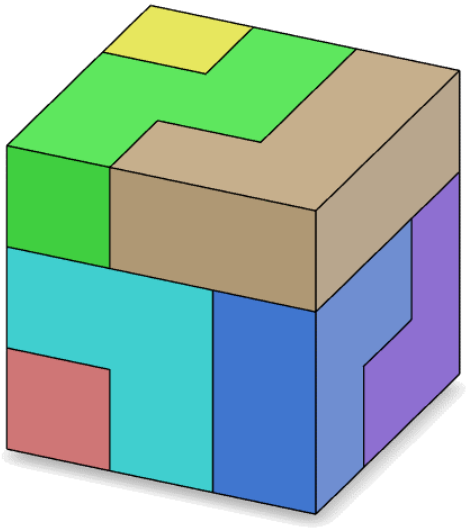
- How does changing the number or shape of pieces affect the difficulty level?
- What are some real-world applications of snug-fitting, interlocking designs (e.g., furniture, manufacturing)?
- How do tolerances vary between 3D printing and other manufacturing methods, and why?

OPTIONAL CHALLENGES

Group Activity: Each team designs a single puzzle piece. Combine them to see if a unified cube can be made.

Design Twist: Incorporate negative space or hollow areas into pieces for added complexity.

Speed Challenge: Assemble the cube in the fastest time.



ADVANCED OPTIONS

- **Incorporate Mechanisms:** Add moving parts or rotating components within the puzzle.
- **Algorithmic Design:** Use parametric modeling to create a puzzle that adjusts dimensions based on input values.
- **Design for Manufacturing:** Optimize parts for specific production methods like injection molding.

ASSESSMENT CRITERIA

- Does the puzzle fit together?
- Do the pieces fit together snugly, but not too tight (appropriate tolerances)?
- Are the individual pieces unique (not just several cubes that stack)?
- Were the pieces sanded/painted/finished for presentation?

ADDITIONAL RESOURCES

- LINK TO DOCUMENTS
- LINK TO YOUTUBE VIDEO
- LINK TO STEP-BY-STEP

PUZZLE CUBE IDEAS

