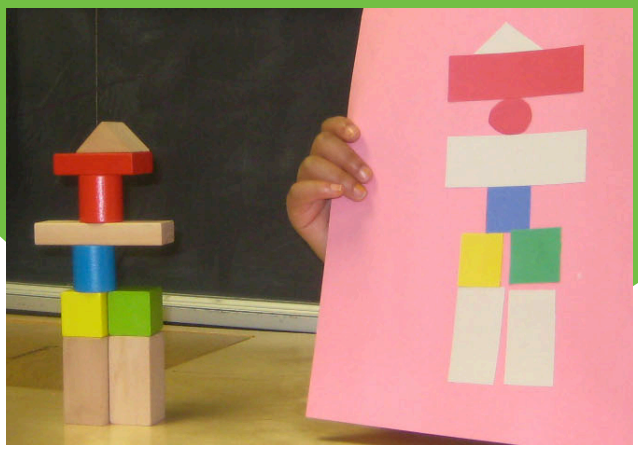
Build and Draw

Math As a Visible Language



Introduction

The best way for children to learn any new math concept is through hands-on experiences that allow them to play with and organize objects. When learners build three-dimensional structures with blocks and then translate the structure into a sketched two-dimensional image they are practicing important math skills and building their understanding of symbolic representations.

LEARNING OBJECTIVES

Children will:

- build three-dimensional structures with blocks or any available objects suited to building structures;
- sketch two-dimensional pictures that represent the three-dimensional structure; and
- explore and write the appropriate equations for mathematical operations by adding to, subtracting from, multiplying, or dividing parts of the sculpture.

Supplies

- Building Materials (blocks, food boxes or cans, or recycled cardboard containers)
- Crayola® Crayons, Colored Pencils, or Markers
- Paper (plain white or construction paper)
- Crayola® Blunt Tip Scissors
- Crayola® Glue or Glue Stick

Prepare

This project requires an area where children can build three-dimensional structures with objects that may topple over during building experiments. They will sketch the structures after they are built. Help children gather appropriate building materials which might include traditional blocks, different sizes of plastic containers, cardboard boxes, or canned goods.

Vocabulary

balance	three-dimensional	sketch
weight	two-dimensional	compare
equal	pictorial	tangible
symmetry	symbolic	equation
representation	sculpture	

Essential Questions

- What math attributes are important for building successful three-dimensional structures, for example balance, proportion, and weight? How do children learn from trial and error when building these structures?
- Why is it important for learners to follow the progression from tangibly exploring objects to sketching a visual representation of those objects and then to writing the symbolic mathematical equations that pertain to those objects?

Guiding Questions

- How does touching then building with objects and then sketching what was built help make abstract math concepts feel accessible and relevant to real life?
- What skills do learners develop as they sketch pictorial images that represent tangible structures?
- Why are symbolic representations easier to understand when they represent actions that have been experienced with real objects?

Applying Math Processes to this Project

PROBLEM SOLVING:
How can available materials be organized into a three-dimensional structure? What keeps the structure from falling? When the structure topples, what causes the objects to fall?

COMMUNICATION:
How can a two-dimensional sketch represent a three-dimensional structure? Why are pictorial images important to communicate ideas?

REASONING & PROOF:
What reasoning was used to make changes after the structure fell? How did making mistakes and causing the structure to topple create learning opportunities?

CONNECTIONS:
What real-life professionals use the skills developed in this activity, for example architects, engineers, construction workers, designers, and sketch artists? How might learners further research these types of careers?

CREATE

- Begin by having children build three-dimensional structures. Urge them to explore stacking objects in various ways. Discuss math vocabulary such as balance, weight, proportion, equal, and symmetry during this experimentation phase.
- After the children have decided that one final structure is ready, move to the pictorial representation part of this project. Children can decide whether to create their two-dimensional representation by sketching it or using construction paper cut-out shapes that they glue together.
- Have them use symbolic representations that demonstrate math operations appropriate to their age and learning objectives such as addition, subtraction, division, and multiplication.
- Children could also measure the structures to calculate the length, width, and height of the total structure or the individual building blocks/components and compare the three-dimensional measurements with their two-dimensional sketches.

PRESENT

- To help children plan the presentation of this project, ask them to assume the role of an architect, designer, or engineer who is making a pitch to potential clients or users who may be interested in building a home, school, hospital, or other structure.
- How would that professional explain the structure and convince the clients that it meets their needs?
- How will the three-dimensional structure and the two-dimensional picture be used in the presentation? How will the equations that show symbolic representations help explain the models?

RESPOND

- Have children plan additional construction projects so they can respond to insights they learned during the original building. What misplaced building blocks or components might be used in different ways to achieve a stronger foundation or more balance and durability?
- Look around the neighborhood or at buildings in books or online to compare and contrast features observed in real buildings with those used in the children's hand-built structures.

CONNECT

- Ask children to identify professions that create tangible three-dimensional models and two-dimensional pictures, and connect those with the symbolic equations they are studying. Have them do research on the various roles involved in a construction profession, for example, in an architectural firm where architects, designers, engineers, draftspersons, and statisticians work together, each contributing unique talents.

For Younger Children

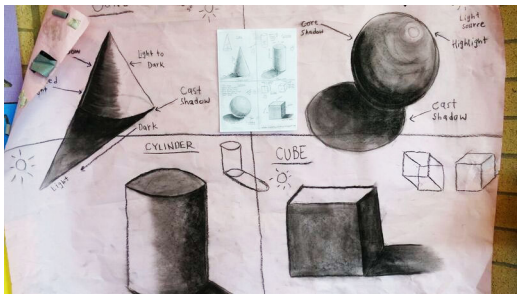
- Have younger children create two-dimensional paper cut-out shapes that mimic the forms they are using to build. Trace, count, and organize the paper cut-out shapes before assembling them in a collage that replicates the three-dimensional structure.
- Label the shapes with terms such as square, rectangle, circle, and triangle. Label the forms with terms such as cube, cylinder, and prism.

For Older Children

- Children could use digital media such as cell phones or digital cameras to capture their work and the work of younger siblings while the constructions are in process.
- Build mathematical vocabulary by using the terms *scale* for size, and *tangible, pictorial,* and *symbolic* for representations of objects in space.
- Speak with an architect or research an architectural firm to discover what structures they have built or are building. Explore how they used three-dimensional and two-dimensional models in their planning. Research what materials were used for a particular building and calculate how much the structure might cost to build.

Child Reflections

- What challenges did you experience and what insights did you learn when constructing your tangible three-dimensional structure?
- How did sketching a pictorial version involve different ways of thinking about and seeing the structure?
- What math equations could pertain to the tangible and pictorial versions of the structure?
- How might this activity be adapted and used again? For example, could you construct a setting that was described in a book or create an imaginary building for a story that is yet to be written?



Adult Reflections

- How did moving through the progression from tangible to pictorial and finally symbolic representation help children understand and help you observe their development of abstract thinking?
- How was the project modified to make it more challenging or less difficult for children based on their readiness?
- How was learning demonstrated during each part of this project? What feedback from children helped shape their work and future plans?

Standards and Skill Development

Standards provide a map of what children should know and be able to do, which helps teachers and families plan in developmentally appropriate ways and recognize when children are ready to progress to the next level. This project addresses the following standards:

LANGUAGE ARTS

- Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
- Present information, findings, and supporting evidence such that listeners can follow the line of reasoning, and ensure that the organization, development, and style are appropriate to task, purpose, and audience.
- Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

MATHEMATICS

- Reason using shapes and their attributes.
- Draw, construct, and describe geometrical figures and describe the relationships between them.
- Look for and create constructed structures and patterns.
- Use three-dimensional forms, two-dimensional shapes, and math operations to solve real-world problems.

SCIENCE

- Ask questions and define problems.
- Develop and use models.
- Plan and carry out investigations.
- Construct explanations and design solutions.
- Obtain, evaluate, and communicate information.
- Define a simple design problem that can be solved through the development of an object, tool, or process that includes several criteria for success as well as constraints on materials, time, or cost.
- Convey designs through sketches, detailed drawings, or physical models. Use these visual representations to communicate ideas and solutions.

VISUAL ARTS

- Document early stages of the creative process visually and/or verbally in traditional or new media.
- Engage in self-directed, creative art making.
- Apply knowledge of available resources, tools, and technologies to investigate personal ideas through the art-making process.
- Design and create art with various materials and tools to explore personal interests, questions, and curiosity. Identify a purpose of an artwork.
- Design or redesign objects, places, or systems that meet the identified needs of diverse users.
- Identify reasons for saving and displaying objects, artifacts, and artwork.

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