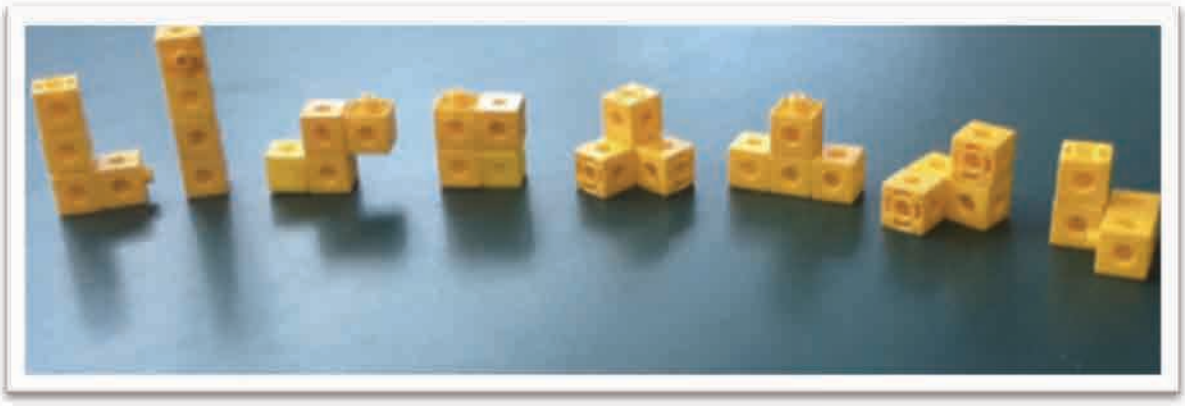
Welcome to the Math for Young Children

Blantyre Lesson Study Team

Public Lesson

2012

Creating Unique 3D Figures: A Lesson in Discovering "Sameness" Through Flips, Turns, and Rotations



The 4-Cube Challenge
Student Discoveries

Presented by the Teacher-Researcher Team

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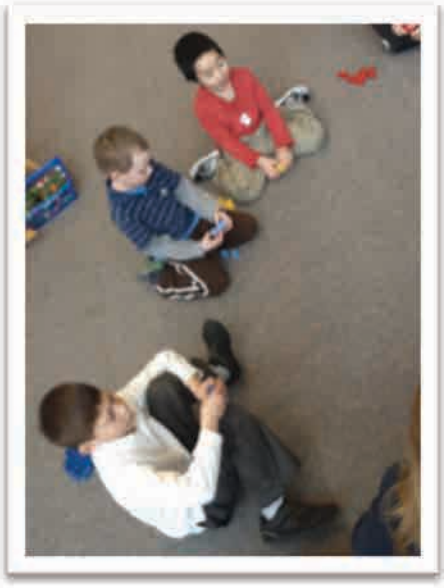
Creating Unique 3D Figures: A Lesson in Discovering "Sameness" Through Flips, Turns, and Rotations

Summary of Lesson: In this lesson students will be challenged to build unique 3-dimensional shapes using 3, 4, or 5 interlocking cubes. Through teacher-led discussion students will come to the realization that certain 3D shapes are the same despite differences in their orientations. For example, a 3-dimensional 'L' shape can be made to look like a '7' if rotated 180°. As students progress from building with 3 interlocking cubes to eventually building with 5 interlocking cubes, students will be increasingly challenged to think of the multiple combinations in which the interlocking cubes can be combined to create new and unique 3D figures.

Learning Objectives: Through this lesson students will come to understand that certain 3D figures, although different in orientations, can be flipped or rotated and be made to look the same. In discovering how and why some 3D shapes are the same, students will also come to learn how and why some 3D shapes are different.

Materials: Each participating child requires a box/container of approximately 60-80 same coloured interlocking cubes. Note: while each child requires the same coloured cubes it is not necessary that all children use the same coloured cubes.

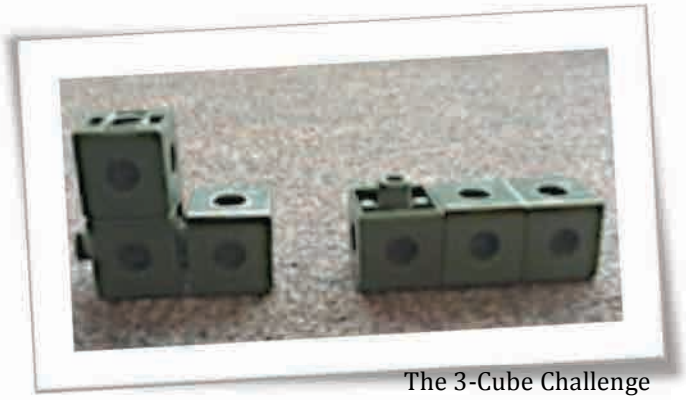
Introduction the 3-cube challenge:



Have children sit in semi-circle and hand out individual boxes of cubes to each participating child. Tell students to take 3 blocks from their collection and ask students to make any shape they would like with the 3 cubes. When all students have produced one shape, have children place their shape on the rug in front of them. Challenge students to take out 3 more cubes and make a second *different* shape. Instruct students to leave the second shape beside the first. Challenge the students further by asking them if they can create any other shapes with 3 cubes that are different from their first two. At this point, some students might come to realize that it is not possible to build a third unique shape with 3 cubes. Other students might build a third and fourth shape and insist that they are different because of how they can be oriented. To help all students see that there are only two unique possibilities to construct 3D shapes with 3 cubes and invite students to hold up their various shapes. As a class discuss how some shapes can be seen as the same and some can be seen as different. Eventually, with minimum teacher guidance, students will come to see that only 2 unique combinations exists and that while some shapes may look different (e.g., '7' vs 'L') when they are flipped or rotated they actually are identical in structure.

Before moving onto the next challenge, be sure that all students are made aware that there are only 2 possible shapes that can be made with 3 cubes. Also, during this initial challenge, students may need to be told/shown how to assemble cubes in a way that all edges are flush with one another (e.g., shapes should not rest on one another in a twisted fashion).

Since there are only 2 different configurations that can be made with 3 cubes, the first (3-cube) challenge can be seen as a warm-up/introductory activity. Thus, the general approach the teacher will take and the explanations of the constraints of the task will come out in the initial round of the game.



The 3-Cube Challenge
Student Discoveries

The 4-cube challenge:

Discussing discoveries

Introduce children to the next challenge by inviting students to see how many different shapes they can make using 4 cubes this time (possible combinations = 8). Before students start to build, ask students to estimate how many different shapes they think they can make using only 4 cubes. Provide children with lots of time to

construct their shapes and provide guidance when need be (e.g., Teacher Prompts: How do you know you have all of the combinations? Explain how these two are different.). Some children may need to be reminded that two shapes are actually the same despite differences in their orientation. Students may also need some scaffolding to move beyond making 2D shapes (3D shapes that lie on their sides with no protruding cubes - the shape 'L' would be an example) and onto 3D shapes with protruding cubes. Once students have had time to make at least 5 different shapes, you may want to have students share their shapes as a class.

The lesson then proceeds with the examination of each child's work. Challenge the class in considering whether two people have the same or different shapes and work together to determine whether all of the possible combinations have been made. If they haven't, tell students that ***x*** number of shapes have yet to be constructed. Hold up examples from each child's set and asks them to talk about what the shapes look like (e.g. a "square," a "T," an "L" or if you flip it a "7", etc.). Encourage children to view the same shape in many different ways to get at the idea that 3D figures are the same despite different orientations. Allowing children to label their shapes and compare them to other shapes and concepts (letters, animals, etc.) provides students with a flexible approach to 3D shape identification.

Have a student pick their favourite shape. The student hides their shape from the rest of the group. S/he describes the shape to the others to see if they can find their shape that looks like the "mystery shape". Repeat this activity a few times to promote positional and transformational language.

To end this challenge, return to their original estimates and ask whether or not their estimates were accurate (you may also wish to touch upon this aspect earlier in the lesson). Ask why there is such a difference between the number of shapes using 3 blocks (2 shapes) and using 4 cubes (8 shapes).

The 4-Cube Challenge
Student Discoveries

The 5-cube challenge:

Challenge pairs of students to construct unique shapes using 5 cubes. This time the maximum number of unique combinations is 29. Follow the same lesson sequence as above, knowing ahead of time that it is not expected that all 29 combinations will be constructed. Again, prior to their building, have the students estimate how many different configurations they think is possible building with 5 cubes. After students have built a sufficient number of different shapes (consider time spent working and/or number of different shapes built) have students in turn share their two favourite shapes and explain whey they chose those shapes. Encourage students to compare their two favourites and label their shapes and compare them to other shapes and concepts (letters, animals, etc.).

The 5-Cube Challenge
Student at work…

Extensions:

Students from K-3

The Barrier Game

Developing spatial reasoning and language with barrier games

The Barrier game requires a listener and a speaker, two identical sets of materials and a barrier such as a large book or science board. The materials for this particular game include the use of unfix cubes, although other manipulatives such as blocks and Lego can be used.

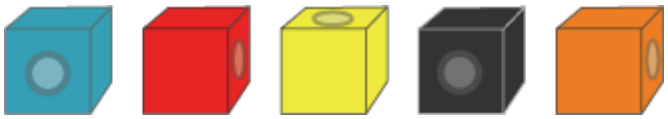
1. Each player has one set of identical cubes. Children should sit facing each other with the barrier between them.
2. Explain to the children that they are going to play a game where they will take turns building a shape using cubes. Once the first child has finished building, they are to describe it to their partner so that he/she can build the identical shape. Children may be using spatial orientation language such as: above, below, to the side, left, right, behind etc.
3. Once the second child has built the shape, remove the barrier and have the children identify if the shapes are the same. If they are simply rotated or flipped, but appear different to the children, ask them if they could move the second shape to make it look like the first. If it is completely different (error in explanation or understanding), ask the children what other words they could use to explain their shape if they were to do it again. You may want to start from the beginning and guide the child through their explanation.
4. Play again, allowing the children to take turns describing their shapes.

For younger children, start with 4 cube shapes to test their abilities. Increase the amount of cubes based on their level of understanding, age and engagement.

**You may wish to photograph examples of different shapes that can be created for children to use as a starting point, although this is not necessary.*

'Building with Cubes'

Imagine you have five cubes; **blue**, **red**, **yellow**, **black** and **orange**.



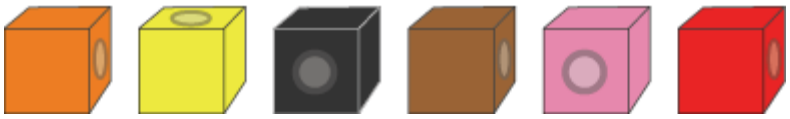
Now imagine making this building in your mind.

Start with the **yellow** cube.
Put the **black** cube just behind it.
Put the **orange** cube on top of the **black** cube.
Put the **red** cube on the left of the **yellow** cube.
Put the **blue** cube on the right of the **black** cube.

What does your building look like?
Use the cubes to check whether you had pictured it correctly.

'Building with Cubes'

Imagine you have six cubes; **orange**, **yellow**, **black**, **brown**, **pink** and **red**.

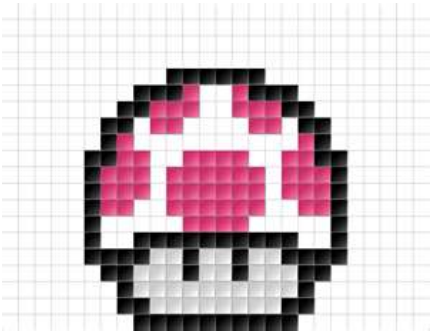


Now imagine making this building in your mind.

Start with the **red** and the **black** cubes.
Put the **black** cube underneath the **red** cube.
Put the **orange** cube on the right hand side of the **black** cube.
Put the **yellow** cube just in front of the **orange** cube.
Put the **pink** cube on the right hand side of the **yellow** cube.
Put the **brown** cube on top of the **pink** cube.

What does your building look like?
Try using cubes to check whether you had pictured it correctly.

Pixel Art



Did you know that most “old school” video game characters are created by pixels? This 3-D art extension captures the interest of students of all ages.

With younger students, simply make a character representation on graph paper (regular or chart) using square stickers or by colouring in the squares. Create a centre with it by providing bins of centicubes or interlocking cubes for students to explore with. You can also construct half of the character and have the students complete it to develop their sense of lines of symmetry.

For older students, encourage them to design their own video game character and build it using different elevations or layers. Wooden craft cubes and hot glue can be used with older students, so creations can be displayed and/or taken home!