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## Pattern Block Puzzles [Grades PreK-3]

Regents' Center for Early Developmental Education

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# Pattern Block Puzzles

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## Materials Needed:

- Pattern Blocks
- Pattern Block Puzzle Frames



## WHY USE PATTERN BLOCK PUZZLES?

### Pattern Block Experiences Address Four of the Nine Big Ideas in Early Math

Within the Nine Big Ideas in early childhood mathematics, Pattern Block Puzzle activities engage children in four, including two that are often neglected: *shapes* and *spatial relationships*.

- **Sets and Sorting**
- Number Operations
- Measurement
- Number Sense
- **Pattern**
- Data Analysis
- Counting
- **Shapes**
- **Spatial Relationships**

The National Council of Teachers of Mathematics (2000) acknowledges the importance of identifying shapes, but also stresses that a child's construction of an understanding of shapes goes beyond just rote memorization of shapes. Children should engage in activities with shapes that also challenges spatial reasoning. Spatial reasoning is the cognitive process involved in constructing (mental) images of shapes and being able to predict the effect of rotating or flipping a shape. When children are engaged in spatial reasoning, they begin to use words and language that describes spatial relationships such as *inside*, *outside*, *top*, *bottom*, *middle*, *next to*, *through*, *around*, *beside*, *behind*, *in front of*, etc. They investigate what happens when they put together various shapes to create new shapes, and take apart shapes to look at the smaller shapes used in creating the larger.

### Research shows that geometrical reasoning impacts mathematics achievement.

- Spatial thinking skills are **indicative of intelligence**
  - While some children are able to express mathematical intelligence through verbal explanations, spatial thinking ability can be revealed through performance at a level higher than they can verbalize.
- Spatial thinking is highly related to **creative problem solving** in mathematics
- Children who develop strong spatial thinking skills often end up in **honors mathematics courses**

## STANDARDS THAT ARE ADDRESSED WHILE WORKING WITH PATTERN BLOCK PUZZLE FRAMES: ([WWW.NCTM.ORG/STANDARDS](http://WWW.NCTM.ORG/STANDARDS))

### Analyze the characteristics and properties of two-and three-dimensional geometric shapes

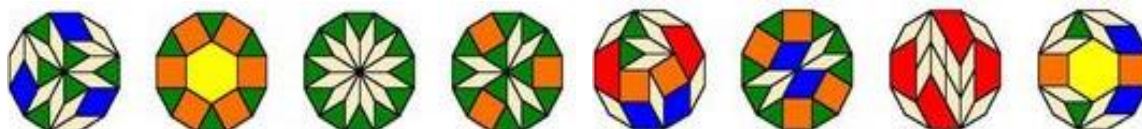
- Recognize, name, draw, compare, and sort two-and three dimensional geometric shapes
- Describe attributes and parts of two-and three-dimensional geometric shapes
- Investigate and predict the results of putting together and taking apart two-and three-dimensional geometric shapes

### Apply transformations and use symmetry

- Recognize and apply slides and turns;
- Recognize and create shapes that have symmetry

### Use visualization, spatial reasoning, and geometric modeling to solve problems

- Create mental images of geometric shapes using spatial memory and spatial visualization
- Recognize and represent shapes from different perspectives



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## PROGRESSION OF CHILDREN'S THINKING WHILE ENGAGING WITH PATTERN BLOCK PUZZLE FRAMES

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1. Child stacks and/or arranges blocks without regard to the perimeter of the frame.
2. Child uses pattern blocks to make designs that are recognizable but without regard to the perimeter of the frame.
3. Child sorts or arranges blocks according to the characteristics of the blocks but without regard to the frame.
4. Child chooses pattern blocks after observing peer(s) complete a frame and selects blocks based on the success of the peer without regard to the frame he/she is completing.
5. The child inserts or attempts to insert blocks into impossible spaces.
6. The child completes the frame and believes it is correct even though he/she has created impossible spaces.
7. The child brings block close but discards before attempting to insert into impossible spaces.
8. The child removes offending block when its insertion creates an impossible space.
9. The child inserts only blocks, or combinations of blocks, that match angles in the perimeter of frame.
10. The child removes block when its insertion fits into an angle but eventually causes impossible spaces.
11. The child matches the angle of the pattern block with the angle of space inside the frame by picking it up and placing it into the frame (may require trial and error).
12. The child matches the angle of the pattern block with the angle of space inside the frame by picking it up and placing it into the frame with no trial and error.
13. The child can look at a frame and choose the correct pattern blocks with no hesitation and without error.
14. The child completes a frame correctly and then is able to complete it again with a different combination of blocks.
15. The child can articulate his/her reasoning about how the frame was completed.

## INTRODUCING PATTERN BLOCKS AND PUZZLE FRAMES

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### Introduction at a Center

Some teachers simply set the pattern blocks out at a table and begin working with them. Children are drawn to where adults work and will engage in conversation with the adults on what they notice about the blocks and what they can do with them. Teachers can photograph the child's work in process, take language samples of the conversation, or print out the picture of the child and act as a scribe to document what the child believes the photo of them represents. Older children can write on their own.

### Whole Group or Small Group

Teachers can introduce pattern blocks to children in a large or small group by providing an assortment of pattern blocks to each child. Lead a discussion on what they notice about them. You may wish to integrate literacy by documenting their ideas on chart paper. End the introduction with an invitation to work with the pattern blocks at a specific location within the room with the plan of coming together and talking about them again later.

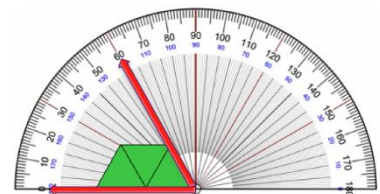
When children's interest starts to wane in this center, call the group together and review what they found out about the pattern blocks. Document their findings on chart paper. Introduce the puzzle frames to the children and demonstrate how the pieces can fit within the frame. Show the selection of the frames in a small tub, and invite them to see how they can fill the frames. Challenge them to see if they can fill the frames in different ways, or if there is only one way to fill it.

## EXTENDING THE STUDY OF PATTERN BLOCK PUZZLES

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As children work with the blocks, they will begin to notice how some blocks can substitute for others. For examples the blue rhombus, green triangle, and red trapezoid all have a 60-degree angle. The yellow hexagon, blue rhombus, and red trapezoid all have a 120-degree angle. Children may describe these commonalities as "having the same corners." Document these discoveries in the children's words and post them on the wall.

Children may notice that a combination of smaller shapes can generate the same shape of a larger. For example: two green triangles can make the same shape as a blue rhombus; six green triangles - the yellow hexagon. Two red hexagons - a yellow hexagon. Three blue rhombuses - a yellow hexagon. A blue rhombus and a green triangle - red trapezoid. Document these discoveries in the children's words and post them on the wall.



Children may notice they can fill a puzzle frame several different ways. By lifting off the wooden frame, they can leave one solution and begin to work on another. Teachers can photograph a child's collection of solutions and document a child's cognitive flexibility.

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## TEACHER TIPS

- Use only plastic pattern blocks as they are more precise than the wooden
- Create your own frames by making shapes with pattern blocks, taping them together, and then tracing around them on a square of mat board or foam core. Use an exacto knife to remove the middle. Number the frames. -Or- purchase wooden frames from [www.patternblockpuzzles.com](http://www.patternblockpuzzles.com).
- Place empty frames on end in a small basket by pattern blocks so children can flip through them to select their own challenge
- Point out the frames are numbered. Children can use these numbers to communicate to peers about which frames they worked with (an authentic challenge to learn number names).
- If children ignore your question or comment as you watch them work, resist the temptation to solve the puzzle for them. They need to test their own ideas to find out what does and does not work. This is the only way they will construct a deep understanding of spatial relationships.
- Experiment with materials before presenting them to young children.
  - Personal experimentation helps teachers think about children's thinking as they struggle with the problems presented by the materials.
  - Personal experimentation helps teachers share children's emotions/frustrations/joys.
  - Personal experimentation assists the teacher in thinking about potential vocabulary they can use in conversation as children work

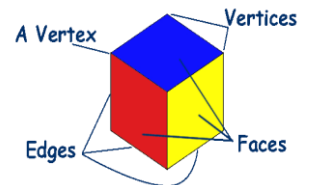
## COMMENTS OR QUESTIONS TO DEEPEN CHILDREN'S REASONING AND DEVELOP PERSEVERANCE

- Can you show me how you filled this frame?
- I wonder if there is a different way to fill it. Do you want to try? May I try?
- I wonder how many ways you can fill this frame?
- I notice it fits one corner, but it won't let any other shapes fill the space on the other end. I wonder what else we can use instead of that shape?
- What would fit there? (Pointing to an angle in the frame)
- Sometimes when I get stuck, I take out some blocks and try others.
- You filled that fast! Would you like to try a tricky frame?
- This is a tough challenge, but you are sticking with it!

## VOCABULARY FOR TEACHERS

As teachers work with pattern block puzzle frames, they may reacquaint themselves with vocabulary within geometry. This will be helpful in communicating with other teachers about the potential of these materials as well as discussing what children are noticing about shapes and composing and decomposing shapes.

- **vertex**
- **face**
- **edge**
- **polygon**- a flat many-sided figure with all straight lines joined
- **triangle**- a flat three-sided polygon
- **quadrilateral**- a flat four-sided polygon
- **trapezoid**- a quadrilateral with a pair of parallel sides
- **parallelogram**- a quadrilateral with opposite sides parallel
- **rectangle**- a quadrilateral with four 90° angles (resulting in opposite sides being parallel)
- **rhombus**- a quadrilateral with four equal sides (resulting in opposite sides being parallel)
- **square**- a quadrilateral with four 90° angles and four equal sides
- **hexagon**- a flat six-sided polygon
- **positive and negative space** – Positive shapes (pattern blocks) occupy positive space (the open middle of the frame). The area around positive shapes, the background, is negative space. In pattern block puzzle frames, the constraints of the negative space (wooden frame) challenge children to fill the positive space in the middle in a variety of ways



## VOCABULARY TO USE WITH YOUNG CHILDREN WHEN WORKING WITH PATTERN BLOCK PUZZLE FRAMES

- |             |             |           |              |               |
|-------------|-------------|-----------|--------------|---------------|
| • triangle  | • square    | • frame   | • substitute | • outside     |
| • rhombus   | • rectangle | • face    | • fill       | • symmetrical |
| • trapezoid | • corner    | • edge    | • empty      |               |
| • hexagon   | • space     | • overlap | • inside     |               |