

# **Patterns Here, Patterns There, Patterns Popping Everywhere!**

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## **Overview**

This unit on patterns is designed for a preschool classroom. Problem solving techniques, such as drawing a picture or making a list, might be difficult for young children just beginning to understand the abstraction of numbers as separate from concrete objects. Looking for a pattern, however, is a natural technique that even infants use to make sense of their worlds. By recognizing, developing and expanding upon four year olds' natural ability to see and follow patterns, I hope to carry over this skill to their developing mathematical concepts, and to help them apply this skill in appropriate problem solving situations.

Rather than only teaching patterns as a discrete unit, it seems to be more natural and useful to try to recognize and teach the patterns that pervade the curriculum throughout the year. Within the unit, I give an introduction to patterns as well as examples of lessons using pattern recognition, creation and application through different thematic units and in different curricular areas, all building on the skill of patterning as a way to help children solve problems and make sense of what they are learning.

## **Rationale**

Our world is full of patterns. An incoming snowstorm is predicted based on the patterns of warm and cold fronts, where they originate, the directions in which they move and the climate conditions they will confront. The kitchen in our home is replete with patterns, from the tessellated floor tiles to the borders on the plates that we place on the table in a set and repeating pattern of dinnerware. Music and poetry are based on repeating patterns and rhythms. Dance is a pattern of movements combined with rhythm. The underlying grammar of the languages we speak is based on repetitive and predictable

patterns. The physical structures of nature, from the design of a spider's web to the spiral of a nautilus shell are patterned. Not only are patterns omnipresent and structural in our lives, but they bring along with them order and beauty, providing both predictability and connection. Recognizing and understanding these patterns helps us make sense of our environment and our world. When we perceive a basic pattern we can anticipate its extension and predict what will come next.

Infants learn to recognize the patterns of face and voice of their primary caregivers. Young three and four year old children depend on the patterned routines of their days to feel a sense of predictability and control over what they do from day to day and how their basic needs will be met. Preschool children are highly invested in trying to make sense of their world. They thrive in environments with routines, predictable schedules and regular cues that help them know what is likely to be happening next. If the pattern is known and adhered to, life is predictable, and these young, small and highly dependent people are able to feel more in control and independent. When a regular pattern is broken or changed, there is an element of surprise and "specialness". When there is no pattern or schedule, there is often a high level of individual discomfort in young children, and in a group this can soon lead to chaos. Pattern and predictability are the constants in a well-run preschool classroom, allowing room for children to develop skills and work independently because they know the basic structure of the day and activities.

Children's literature is based on patterns that help children relate to stories and anticipate what will happen next. Stories based on the number three (Goldilocks and the Three Bears, The Three Billy Goats Gruff, The Three Little Pigs, etc.) are very popular with preschoolers and are among the first folk stories which they retain and can retell on their own, even to the point of extending the patterns to create their own variations. The Four Little Pigs, and The Wolf and the Three Bears are two of my favorite retellings. Numbers and patterns are becoming more and more common in children's literature as children's natural fascination with patterns is applied to the burgeoning fields of non-fiction and concept-based fiction for pre-readers and young readers.

## **Mathematical Background**

Pattern is a unifying theme that weaves mathematical topics together. The study of patterns supports children in learning to see relationships, to find connections, and to make generalizations and predictions. Understanding patterns nurtures the kind of mathematical thinking that helps children become problem solvers and abstract thinkers. It is a problem-solving tool. (Burton et al.1)

The NCTM standards for kindergarten recommend that children begin exploring physical patterns with their own bodies seeing, doing and naming actions that repeat patterns. Through their own bodies, their own actions and those of their friends, children can see clearly the relationships of what they and their peers are doing. A common

preschool activity is making body movements in patterned sequences. For example, children's hands clap, tap knees, clap, tap knees, and so on. Adding word labels along with the body movements helps some children as they chant along: "Clap, tap, clap, tap." A yet more abstract method that helps with later recording of the patterns involves giving them symbols similar to those used in algebra: clapping is A, tapping is B and children chant "ABAB."

A second level would be patterning with objects, whether they be stuffed animals, pine cones, buttons, small toys, macaroni, attribute blocks, colored cubes, sea shells or pieces of paper. Again, these may be used to have children recognize, name, continue and discuss patterns. Classification and sorting are clearly related mathematical skills and may also be done with the same objects. Classification requires children to perceive similarities and differences and to group the items accordingly. Most open-ended materials allow for many different ways for items to be sorted, encouraging independent thought and providing children with strong feelings of success. Once they are facile at sorting and classifying, they are ready to look for patterns made from objects that are both similar and different. After children learn to see, describe and continue patterns made by others, they should then be given the opportunity to create their own patterns to share with others and for others to continue. Translating patterns from objects into words or into different media is also a useful skill extension.

A third level of patterning, after using bodies and objects, would involve using pictures and symbols to create and represent patterns. There is some controversy in early mathematics education about whether symbols should be introduced while children are still learning concepts, or not until later, when the symbol may be used to label what is already known conceptually. I tend to introduce the symbols after concrete objects, but not necessarily after the concept is "known", as I believe that both can stimulate the internalization of the other. Pictorial patterns using stamps, stickers or representations of concrete objects (images of Unifix blocks, for example) are more abstract and should be connected with real objects whenever possible. Models can be recorded with symbols onto paper, and paper models can be used to guide the creation of physical models.

Within each of these levels, Kathy Richardson describes ways to help record and analyze children's sequential progress in patterning:  
"Can the child:  
Copy patterns?  
Extend patterns?  
Describe patterns with words? with ABC's?  
Build a pattern when given a rhythmic pattern? ABC's?  
Create his or her own patterns?  
See patterns in series of numbers and make predictions? using a 00-99 chart? without the help of a chart?" (51)

By noting these levels and specific patterns with which children may have difficulty at each step, simpler examples (AAB, AB, AABB) may be introduced and built upon until the child is ready to make progress to a more complex pattern (ABACAD, ABBCD) or a higher-level skill.

## **Strategies**

Some of the strategies, which will be used in this curriculum unit, include the following:

- “pattern walks” both within and outside the school will be taken to help the children increase awareness and spot patterns in the world around them (e.g., floor tiles, offset bricks on the wall, placement of flowers outside the school, fence structures, footsteps, bulletin board arrangements, placement of snack items) and label them;
- whole group circle time activities, modeling simple patterns which the children can all help to create, add to and label;
- small group activities with more personalized activities, such as games where children follow patterns created by an adult (e.g., linear color-based patterns with Unifix cubes), extend the patterns and help name them;
- these would be extended, once the children are able, by asking them to create their own patterns of the same sort for the teacher or a peer to continue;
- patterns recorded on paper could be used to create visual displays, individual books or classroom books for the children to read and use (e.g., “What Comes Next?”), as well as for assessment purposes.

Manipulatives are used regularly in the classroom. Initial use is often free and exploratory to facilitate children’s comfort and familiarity with the materials. As the children become increasingly comfortable with the manipulatives, teachers introduce more structured uses for them. For example, geoboards are used initially for exploration (with lessons based on safety and ways to manipulate the rubber bands without breaking them or hurting anyone). Later, geoboards are used for shape identification, replication, building and sorting activities. After practicing structured activities such as these with a teacher, the children are allowed to work with the materials independently, with partners or in small groups. Eventually, geometric problem solving questions are solved using the geoboards (e.g., how many triangles fit into a square, or how large should a pasture be to hold 6 sheep). Once children attain an internal comfort and confidence with a math manipulative they will often turn to it spontaneously to help them deal with a difficult concept.

For linear patterns, repetition of units comprised of two, three or four components, I find Unifix blocks the manipulative of choice. Kathy Richardson states that, “Young children need to experience patterns first in motion, color, design, and arrangement. Then from these experiences comes the discovery of the pattern in number” (29). Unifix cubes may be used to represent any other pattern, such as an ABB, clap, tap, tap pattern. Children can do the body movements, say the movements aloud, rename the movements

with ABB, then build a colored representation with cubes linked in a train. Three-dimensional puzzles are also possible with Unifix cubes, as depicted below in Lesson 4.

Pattern recognition is not a clear concept that is mastered and done. Therefore, these activities are especially conducive to repetition throughout the curriculum, and in different formats. They also easily allow for children at varying levels of comprehension to be meaningfully involved in the same task at the same time.

## **Classroom Activities**

### Lesson 1: Where Do We See Patterns?

*Objectives:* Introduce children to the concept of visual patterns and create individual pattern books where they can begin to draw, record and label patterns they find or see in the classroom, school and neighborhood.

*Materials:* chart paper and markers; *Patterns*, by Hammersmith (plus other pattern books from classroom library); 20 page individual books premade for each child with 5 pieces of 8 1/2 by 11 inch paper folded in half and stapled in two places; washable markers; digital camera (and printing capability); button collection; stringing beads; wooden blocks; stacking cups; colored cubes; 80 (4 x 20 children) large craft sticks preassembled into photo frames with multiple small stickers and foam shapes for decorating; materials for pattern snack as described below.

*Procedure:* This lesson would be ongoing over several weeks, allowing children time to experiment with finding and recording different patterns. I will begin the introduction to visual patterns in circle time, when the whole group is gathered together and sitting on the rug. Using a colorful book such as Hammersmith's *Patterns*, I will introduce the class to the photos and text, trying to get them to focus on looking at the patterns as they listen to the text the first time through. The second reading will focus picture by picture on the patterns, asking the children to describe each one in their own words. After finishing the second reading, I will ask the children to help me make a list of places we might look for patterns like those in the book, or other patterns as well (clothing, brick or stone walls, floor tiles, flower beds, decorations outside classrooms or homes, store windows, etc.).

In small group time where I meet with 4 or 5 children at a time while my assistant and parent volunteers work with other small groups, I will introduce each small group to their pattern books. Each child will be able to name their book, label the title and author (themselves) and decorate the cover with a colorful pattern of stickers.

For exercise the next day, weather permitting, the class will go on a pattern walk, looking both in- and outside the school for the examples the children had identified, plus

ones I had prescouted (bulletin board borders, wall and floor tile tessellations, outdoor plantings, etc.). We will bring a digital camera to document what we see. Small group time would be devoted to adding our discoveries to our pattern books, with appropriate labels. These books will be kept in class for the first several weeks and periodically added to as the children discover new kinds of patterns to include. The digital photos will be printed, mounted, labeled and used as prompts for children to use when they add similar items to their own books.

With appropriate questioning (e.g., What pattern can you find in our circle today? What pattern was Ms. Carla thinking of when she got dressed this morning? What patterns do you see in the jewelry in our dress-up area?), children will be encouraged to find and identify patterns inside the classroom as well to add to their books. During their regular weekly “sharing time” (show and tell), children will be encouraged, with the help of their parents, to bring in something that has a pattern in it (a striped hat, a repetitive pattern book, a set of beads with patterned colors, a picture or project they made, a photo of something from their home, etc.). On the day they share this item with the class they will be asked to describe the pattern in it and then be given a chance to add this item to their pattern books.

As children’s experience seeing and identifying patterns expands, teachers will encourage them to “Read the Pattern,” or label what it is they see that makes it a pattern. This is especially useful for prereaders, who can “read” the candy cane colors from left to right, in sequence, (“red, white, red, white, red, white, red, white”) long before they can read any words. In their pattern books, as able, they may label patterns with abbreviated codes, such as “r,w,r,w,r,w,r,w.” This is a precursor to the later labeling of patterns with AB and other codes.

At small group times, open-ended materials such as buttons to sort, beads to string, markers with paper and stencils, wooden blocks, stacking cups and colored cubes will be offered to the children to explore. As children discover their own ability to create patterns, these will be shared with their peers and emphasized, so that the children may teach their friends how to make patterns. These would, of course, be recorded in and added to their pattern books.

An interesting opportunity for learning comes up when the children may identify or create a pattern, which does not work. Young children at age four are not known for their flexible thinking, for the most part, but if a non-pattern is viewed with humor and children are given the chance to identify the problem themselves and to suggest how to fix it, this can be very empowering.

This initial pattern introduction will culminate in a Pattern Party. Preschoolers (and their teachers) love to celebrate and use almost any occasion to do so. Children and teachers will be encouraged to wear patterned clothing and/or jewelry that they will

describe to the group at circle time. We would take a pattern photo of the children to display in a craft stick frame which the children could decorate with a pattern of small stickers and foam shapes. Pattern songs such as “Head, Shoulders, Knees and Toes” and “BINGO” would be sung and favorite pattern books from the classroom library reread. For a treat, children would be given long crackers to spread with soft cheese and decorate with patterns of berries, small cereal shapes, grapes and colored goldfish crackers. They would be eaten as our special dessert after lunch that day. Parents and caregivers would be invited to come early for pick-up so that they could hear each child share two or three favorite patterns from their pattern books, before they were sent home to add to their family libraries.

## Lesson 2: What Do We Do With the Odd One?

*Objectives:* Children will recognize and identify patterns used by different classes for creating lines with which to walk through the school. Children will look at our own class lines (lined up 2 by 2) and examine alternatives. Children will be presented with the problem of an odd number of students and will help to generate alternative patterns for the lines in that circumstance.

*Materials:* Clipboards; pencils; questionnaire for teachers; the children themselves; 20 wooden blocks to represent the 20 children in our class.

*Procedure:* I will introduce the concept with “The Ants Go Marching” song. As the children sing about the ants marching two by two, we will act out the song with two pairs of two children; then two groups of 3 children; then 4s; then 5s; up to two groups of 10 children each (our entire class!). It will be easy to lead the class into a discussion of the various patterns, how they keep increasing and how hard it would be to try to walk with lines of 10 children across through the halls of our school!

So how do most of our classes walk in their lines? With the children’s help, we will devise a brief questionnaire/ survey, asking classes in grades K-3 how their class lines up. My assistant will take a small group of children with her to the different classes to ask their questions and record the answers. When they come back they will report to the whole class what they have discovered with their research. We can discuss the different patterns for our class’ lines as well, and using the wooden blocks we can line up different configurations on the rug to check them out.

One day when an odd number of children are in attendance, before it is actually time to line up to go outside, I will present to the whole group the following dilemma. If we line up two by two, and we have 19 children, what do we do with the odd one? We can line up wooden blocks to see how it works. Can we line up three by three (only works to 18)? Can we do a pattern, two/three/two/three (can do 17 or 20)? What about three/two/three/two (18)? What other choices or options do we have while still keeping a

repeating pattern? I don't know if they'll come up with 2/3/2,2/3/2,2/3, but I'll encourage them to play around with the possibilities, especially focusing on twos and threes so that no one will be alone and no group will be too large. I do anticipate solutions like having the 19<sup>th</sup> child be partners with a teacher, or make one triple to complete the line, but I also anticipate being surprised at how the children approach and solve this pattern problem.

### Lesson 3: Patterns Through the Themes

*Objectives:* Children will continue to see, identify, continue, name and create patterns with different materials and media throughout the year.

*Materials:* See relevant materials under each theme.

*Procedure:* These are some ideas for integrating patterning into different curricular themes throughout the school year. Themes vary somewhat from year to year, but these are some of the more popular and recurring themes that we use.

#### *Apples and Pumpkins:*

In the fall we usually begin with seasonal apples and pumpkins. The children learn to identify their names by "signing in" with red, yellow and green paper apples with their names written on them. Those apples get lined up by the children each morning and easily fall into patterns by color.

Cutting open apples of different colors and shapes and varieties shows the children the same pattern and number of seeds inside. Printing with apple pieces reinforces this. The horizontal star pattern is always a wonderful surprise to four year olds. Connecting the number of seeds to the pattern of petals on the apple blossom flower also shows them the repeating and predictable patterns in nature.

One of our favorite pumpkin activities is turning felt pumpkins into jack o'lanterns with various felt shapes. Two children work together on large cutout felt jack o'lanterns and challenge their partner to make eyes the same as theirs, or different from the ones they chose.

We take a fall walk to the neighborhood garden store to observe the various shapes and varieties of gourds and pumpkins, and to purchase some for our class. We can easily pick out gourds that might create patterns to keep on our science table. The garden store is also full of patterns, most easily visible in the arrangements of chrysanthemums and other flowers.



Decorating the room with paper pumpkins provides another opportunity to arrange them in patterns and to use the various shapes we observed at the garden center. Children can plan a pattern (long skinny pumpkin, short round, long skinny, short round) or whatever they choose, then trace and cut out the appropriate shapes which could be lined up and displayed around the room.

#### *Native Americans:*

We often make and design costumes and drums with the children to use as part of our Wampanoag/Pilgrim loose Thanksgiving reenactment. By looking at pictures of Native American clothing (or real items if we can get access to them), children are able to identify recurrent designs and themes used on the clothing. They can identify zigzag patterns, geometric designs, stylized eagles and other animals. They are then encouraged to use these patterns on their own vests, headbands and drum covers (over coffee cans).

We spend considerable time practicing rhythms on our drums, with a follow-the-leader pattern. First, the teacher leads the pattern and the children join in as they are able. As they get better at following, children are encouraged to take a turn leading the pattern, and we all follow them. Simple patterns build up to more complex ones, beginning with tap, tap, clap; tap, tap, clap and increasing in complexity. Children are encouraged to say the pattern out loud to help them drum in rhythm, rather like a coxswain on a crew boat. Drumming along with certain phrases is very popular and gives the children a familiar “hook” on which to hang the physical motions. “Charlie Brown and Snoopy” and “See you later, Alligator” are two phrases that the children really enjoy, that are borrowed from the Suzuki music program. As they get better at the rhythms and patterns we encourage them to say the words more quietly and focus on the drumming patterns, and then to eventually just say the words in their heads silently as they drum.

#### *Holidays of Light:*

Children often make “stained glass” candles to hang in windows at this time of year. In a black paper cut out frame, the children cover the negative space with various strips of colored tissue paper to create a translucent candle shape. They can be encouraged to make a pattern of appropriate flame colors (yellow, red, orange, yellow, red, orange, yellow), and to choose colors for their candle that form a pattern as well.

The children usually create gifts for their parents at this time of year and use sponge painting to create patterned wrapping paper. First we look at the patterns on commercial wrapping paper, then use seasonal colors and shapes to make repeating patterns on large pieces of newsprint with which to wrap the children’s gifts.

Cuisenaire rods make colorful candles with small rods (white or red) as flames. Using stuffed and paper menorahs to represent the holiday of Hanukah, the children are

encouraged to see the pattern of increasing the number of candles each night by one, and to practice arranging the candles in colorful patterns.

Paper chains of different colors and patterns are also fun to create and use to decorate the classroom.

### *Bodies:*

“Head, Shoulders, Knees and Toes” is a patterned song that the children love. They get to act it out by touching the relevant part of the body, and as we repeat it over and over, each time we leave out one more word and hum that body part while still touching it.

Unifix cubes are used as standardized measurement tools during our body unit, and they are always inviting to arrange in color patterns, even when that is not the primary objective. We measure and chart the lengths of femurs and hands as well as children’s heights.

Likenesses and differences are a big part of this unit. The children are fascinated by all of the things we, as people, have in common. We chart all of the body parts that come in pairs. Then we look at the different ways that variation enters in—eye color and shape, body shape, different kinds of eyes, mouths and hair.

### *Bears:*

The story of *Goldilocks and the Three Bears* is a cornerstone of this unit. There are vast numbers of wonderful variations on the story and we use dolls, puppets and children in costume to act out the basic story. Children love the repetition of the large, medium and small bears with their large, medium and small voices, bowls, chairs and beds. The corresponding repetition of Goldilocks’ complaints, “too hot, too hard, too high; too cold, too soft, too low; and just right” is patterned in a way that uses logical opposites and is very accessible to children.

The children love to line up plastic counting bears which come in red, yellow, blue and green and use them to make patterns to challenge their friends. Sized bears (small, medium and large) are also useful to create patterns utilizing size as well as color, and to reenact the Goldilocks story. Nested wooden bear dolls (like the popular Matriushka dolls from Russia) also encourage children to line up the bears in a pattern of size order, then to reverse the order to nest them back inside the largest doll.

At the conclusion of this unit we usually have a Teddy Bears’ Picnic, and each child brings in a teddy bear for the day. The bears are lined up in size order and we look for other patterns we can create: ribbon, no ribbon, ribbon, no ribbon; brown bear, white bear, brown bear, white bear; clothes, fur, clothes, fur; etc.

### *Insects:*

Insects have three body parts and six legs; spiders and other arachnids have two body parts and eight legs. Looking closely at bugs and at pictures of bugs, we use these rules to help identify and characterize what is an insect or spider and what is not. In making bugs and insects out of playdoh, three-dimensional craft items and drawing materials, children are encouraged to count how many legs on each side a bug has, versus a spider, and to represent those numbers correctly in their artwork. Doubled numbers are very interesting to them and by the end of the unit, children rarely have to count six legs, only three, to identify an insect; or four for an arachnid.

Symmetry is a natural pattern extension as we study and raise our own butterflies and moths. Using mirrors and pattern blocks, children explore line symmetry, and with the help of wonderful software called “Kaleidodraw” they can extend that beyond reflective symmetry to rotational symmetry as well.

Plastic bugs are very inviting for sorting, classifying and creating patterns. We also have bug stamps and stickers that are great for patterning projects. A puzzle of plastic beetles that tile symmetrically introduces children to the concept of tessellations, which they can recreate with pattern blocks in addition to the beetles and the brick patterns which they put in their original pattern books. If children are sufficiently interested and able to understand periodic tessellations, it would be interesting to show them Penrose Tiles, symmetric, non-periodic tessellating shapes called “kites” and “darts,” discovered by Sir Roger Penrose in the 1970s. These shapes can be used to tile with an asymmetrical, non-repeating pattern.

### Lesson 4: Linear Unifix Patterns

*Objectives:* Children will use Unifix cubes to recognize, “read,” make and continue color patterns. They will use the colors to represent movements in an effort to record various patterns, first with blocks and then on paper. Symbolic letters will also be attached to the various color patterns to help children abstract from the concrete movements and blocks, with practice provided in moving back and forth between the concrete and the symbolic.

*Materials:* Assorted Unifix cubes, chart pad, washable markers, papers for a class book.

*Procedure:* Start by reviewing familiar body patterns with the whole group. Tap, tap, clap. Tap, tap, clap. Shoulders, nose, shoulders, nose. Cross one arm, cross two, open one, open two, cross one, cross two, open one, open two. Once the children are comfortable with these movement patterns, bring an assortment of Unifix cubes to the circle. Ask the children how they could use the cubes to show the pattern you are doing (tap, tap, clap). Let each child try to make their own pattern. Show one that fits and ask

the children to “read the pattern,” for example, “yellow, yellow, blue, yellow, yellow, blue.” Choose other children who may have different colors, but the same AAB pattern, to read theirs as well.

Repeat this exercise over several days with different patterns until the children get good at it. Introduce the letters A, B and C, as another way to show tap, tap, clap, and other patterns. Using large chart paper, pick one pattern that the children like to make (e.g., head, head, knees, knees). Ask the children to help you name the pattern—AABB. Write AABB on the chart and ask the children to show with their cubes different ways that they might make AABB. These color trains may be recorded on the chart and posted in the classroom.

In small groups, children can design their own train patterns to be added to a pattern book to be called “What Comes Next? “. Sample patterns would form different pages of the book as templates. Children would be asked to “read” the pattern aloud (“red, blue, yellow, red, blue, yellow”), then make the pattern and continue it as far as they can go. This would become a class book and part of the class library, which children could access and use whenever they chose.

Teachers and children could also make pattern cards using the letters associated with the patterns (AABAAB, ABCABC, ABACABAC) that could be used with the Unifix cubes to match with various color trains.

Cubes may also be placed in patterns that are not trains, for example facing up and down, straight or angled or in various tower heights (one, two, three, one, two, three). The Richardson book also gives numerous examples of “increasing patterns,” which can be made with Unifix cubes. For each pattern the designs grow in a predictable manner. For example, towers of 2,3,2 followed by 3,4,3, then 4,5,4, etc. I’m not sure how preschoolers would do with these more sophisticated patterns, but I see them as a logical extension for children who enjoy the materials and the train patterns done earlier.

## **Annotated Bibliographies/Resources**

### Teacher Bibliography

Allison, Linda. *Eenie Menie Miney Math! Math Play for You and Your Preschooler*. Covelo, California: Yolla Bolly Press, 1993.

A nice resource for parents who would like ways to find opportunities to play with mathematical ideas in various activities throughout the day.

Baroody, Arthur J. “Does Mathematics Instruction for Three- to Five-Year-Olds Really Make Sense?” *Young Children*: 55.4, July 2000: 61-67.

An analysis of what should be included in math instruction at the preschool level and why, emphasizing an investigative and meaningful approach, which empowers children to be positively disposed to mathematics.

Burns, Marilyn. *About Teaching Mathematics*. 2<sup>nd</sup> Edition. Sausalito: Math Solutions Publications, 2000.

This is an excellent resource book for teachers of mathematics in grades K-8. Burns believes strongly in observing children, watching for their patterns of errors, offering concrete materials and teaching math through problem solving situations.

Burton, Grace, et al. *Curriculum and Evaluation Standards for School Mathematics: Kindergarten Book*. Reston, Virginia: NCTM (National Council of Teachers of Mathematics), 1993.

Without having access to a corresponding book for PreKindergarten on curriculum and evaluation standards, this excellent NCTM publication has been my fallback resource.

Dutch, Steven. "Penrose Tiles." 4 Dec. 2009. U of Wisconsin, Green Bay. <http://www.uwgb.edu/DutchS/SYMMETRY/penrose.htm>.

A website from Prof. Steven Dutch at University of Wisconsin, Green Bay with detailed descriptions of Penrose Tiles, their history and the mathematical properties with which they are imbued.

Parsons, Jackie. "Teaching Math Patterns to Young Children: Fun Ways to Teach Patterns at Home." Suite 101.com. 15 July 2009. [http://kids-educational-activities.suite101.com/article.cfm/teaching\\_math\\_patterns\\_to\\_young\\_children-ixzz0kAsF3CqA](http://kids-educational-activities.suite101.com/article.cfm/teaching_math_patterns_to_young_children-ixzz0kAsF3CqA)

A nice reference website for parents who would like more ideas to work on at home.

"Patterns in Mathematics." Annenberg/CPB Math and Science Project. [www.learner.org/teacherslab/math/patterns/index.html](http://www.learner.org/teacherslab/math/patterns/index.html).

A Teachers' Lab website providing information for teachers across the grades about logic, number and word patterns complete with activities and connections to the NCTM standards.

Richardson, Kathy. *Developing Number Concepts Using Unifix Cubes*. Menlo Park: Addison-Wesley, 1984.

This is an excellent resource on creatively and expansively using Unifix cubes, with an especially comprehensive and useful chapter on patterns.

Willingham, Daniel T. "Is it True that Some People Just Can't Do Math?" American Educator Winter, 2009-2010: 14-19.

This is an interesting article about cognitive research on how math is learned from infancy on and the implications of this research for teachers of mathematics.

### Student Bibliography

Aker, Suzanne. *What Comes in 2's, 3's, & 4's?* New York: Aladdin Paperbacks, 1990.  
Using children's bodies and everyday objects from their worlds, the numbers 2, 3, and 4 are shown recurring regularly in daily life. This book is also good for helping children conceptualize organizing their lines in numbers other than 2s.

Anno, Mitsumasa. *Anno's Magic Seeds*. New York: Philomel Books, 1995.  
A wizard gives Jack two golden seeds and directs him to eat one and bury the other, which will grow and give 2 more magic seeds in the fall. Jack does so, and the cycle repeats, until Jack decides to bury both seeds. The growth becomes exponential as Jack buries more and more seeds.

Atherley, Sara. *Math in the Bath (and other fun places, too!)*. New York: Simon & Schuster Books for Young Readers, 1995.  
Includes wonderful everyday examples of patterns, such as flag designs and musical rhythms.

Demi. *One Grain of Rice: A Mathematical Folktale*. New York: Scholastic, 1997.  
It's the story of Rani, a clever girl who outsmarts a very selfish raja and saves her village. When offered a reward for a good deed, she asks only for one grain of rice, doubled each day for 30 days. That's lots of rice: enough to feed a village for a good long time—and enough to teach a greedy raja a lesson.

Gold, Kari Jenson. *What Comes Next? A Beginning Math Book*. New York: Newbridge Educational Publishing, 1999.  
Clear and beautiful photos include non-repeating patterns, challenge children to guess what comes next and explain why.

Hammersmith, Craig. *Patterns*. Minneapolis: Compass Point Books, 2003.  
Environmental patterns in nature, fabric and architecture.

Irons, Rosemary Reuille and Marjory Gardner. *Pretty Patterns*. San Francisco: Mimosa Publications, 1992.  
Kindergarten component piece of the Mimosa "Moving Into Math" program, asks children to recognize and describe patterns.

Koomen, Michele, *Patterns: What Comes Next?* Mankato, Minnesota: Bridgestone Books, 2001.

Asks children to predict the next members of many different kinds of patterns.

Pluckrose, Henry. *Math Counts: Pattern*. Chicago: Children's Press, 1995.

Includes visual examples of patterns, including symmetrical designs and tessellations, and encourages discussion about different kinds of patterns through a question-asking format.

Reid, Margarette S. *The Button Box*. New York: Puffin Books, 1990.

Sorting and categorizing, patterning and grouping.

Satchwell, John. *Odd One Out*. Pleasant Hill, California: Discovery Toys: 1987.

A First Maths book from Great Britain provides experiences with sorting and counting, as well as an introduction to even and odd.

Trail, Leanna. *The Deer and the Crocodile*. Crystal Lake, IL: Rigby, 1997.

A traditional tale involving a deer with a problem and a clever solution.

## Classroom Materials

Wooden Unit Blocks

Colored Cubes

Stringing Beads

Stacking Cups

Collections of sea shells, pine cones, small cars, buttons

Unifix Cubes

Star Shines "Busy Beetles" puzzle by DaMert Company, 1996

"Kaleidodraw" software by Protozone Interactives. Al Jarnow, 2005.

## **Appendix—Content Standards**

These are the relevant Philadelphia PreKindergarten Standards that align with the Pennsylvania Learning Standards for Early Childhood.

### **2.1 Numbers, Number Systems, and Number Relationships**

- B. Use concrete objects to represent quantities up to and including five.
- F. Reproduce patterns using concrete objects.
- G. Use concrete objects to group into sets.
- H. Use concrete objects to demonstrate understanding of one-to-one correspondence up to and including five.

### **2.2 Computation and Estimation**

- E. Make estimates of objects in a set up to and including ten and verify.

### **2.3 Measurement and Estimation**

- H. Identify different attributes of objects (e.g., smaller larger, size, shape).

### **2.5 Mathematical Problem Solving and Communication**

- A. Identify a problem and possible solutions.
- B. Tell others how to solve a problem.
- C. Recognize there is more than one way to solve a problem.

### **2.8 Algebra and Functions**

- A. Recognize attributes of likeness and difference in a group of everyday objects.
- B. Use concrete objects or pictures to identify what is missing.

### **2.9 Geometry**

- A. Recognize common two-dimensional geometric shapes.
- B. Build with geometric shaped concrete objects in play.
- D. Recognize common geometric shapes in real life.
- E. Informally explore symmetry.
- F. Informally explore symmetry in real life.
- G. Explore reflections.
- H. Explore shapes in a reflection.
- I. Explore shapes using concrete objects and pictures.



