Helping Young Children See Math in PLAY

Capitalize on opportunities for mathematical concepts to emerge in common preschool contexts, such as doll corners and block centers.

By Amy Noelle Parks and Diana Chang Blom

In many classrooms today, young children have less and less time for play with materials that support mathematics. Additionally, even when children do play, their mathematical thinking during play often gets overlooked. Consider the following examples:

Jakim struggles to fit a puzzle piece into a twelve-piece puzzle showing an ocean scene. He systematically turns the piece to try to connect each of its sides, not noticing that the piece represents part of an animal portrayed on the opposite side of the puzzle. When he fails to connect the piece, he says aloud, “You just have to keep trying.”

Walking by, the teacher says: “Yes, you’re working hard. Keep trying.”

Across the room, Brian and Leon work to cover a flat Lego square with smaller blocks, removing and adding different-size blocks to cover the square precisely. The paraprofessional watches for a moment before asking Brian to count the blocks he has in his hand. He does, pointing to each one and saying, “One, two, three, four, five.”

Despite the paraprofessional’s move to direct Brian toward counting, important opportunities for broader mathematical learning were overlooked—in both these playtime episodes. Research demonstrates that this overlooking of opportunities to learn mathematics is common in many early childhood classrooms, where teachers are more likely to attend to literacy than mathematics during both formal lessons and play (Ginsburg, Lee, and Boyd 2008; Graham, Nash, and Paul 1997).

However, we know that play provides an important context for children’s exploration and learning. The National Research Council (NRC 2009, p. 339) urges early childhood educators to provide children with “integrated mathematics experiences.” Similarly, the National Association for the Education of Young Children and the National Council of Teachers of Mathematics (NCTM) (NAEYP and NCTM 2002, p. 3) have asked teachers to “provide ample time, materials, and teacher support for children to engage in play, a context in which they explore and manipulate mathematical ideas with keen interest.”

The purpose of this article is to provide strategies for recognizing meaningful mathematics in common play contexts in early childhood classrooms and to offer suggestions for how teachers might intervene in these moments to help children attend to the mathematical ideas embedded in their play.

DOLL: SVETLANA ZAYATS/THINKSTOCK; BLOCKS: NENOVBROTHERS/VEER; PUZZLE PIECE: ANDREW JOHNSON/THINKSTOCK

In particular, we focus on the concepts of composing and decomposing, which are fundamental concepts in early mathematics and essential to the understanding of big ideas in both number and geometry. Composing and decomposing refer to "putting together and taking apart and [apply] to numbers as well as to geometry and measurement" (NRC 2009, p. 352). The ability to recognize a whole as well as the parts that make it up and to move between these ways of seeing a mathematical object is necessary for flexible computation. For example, decomposition is necessary to recognize that a 6 can be a 4 and a 2 as well as a 5 and a 1. Composing and decomposing are also important for the understanding of the relationships among shapes in geometry, such as recognizing that a square can be divided into two triangles. The importance of the intellectual task of composing and decomposing is highlighted in the Common Core State Standards for Mathematics (see **table 1**).

TABLE 1

Composing and decomposing are basic concepts in early math, essential to understanding the big ideas in number and geometry.

Common Core State Standards related to composing and decomposing in primary grades

Domain	Standard
K.OA.3	Decompose numbers less than or equal to 10 into pairs in more than one way (e.g., by using objects or drawings) and record each decomposition by a drawing or equation (e.g., 5 = 2 + 3 and 5 = 4 + 1).
K.NBT.1	Compose and decompose numbers from 11 to 19 into ten ones and some further ones (e.g., by using objects or drawings) and record each composition or decomposition by a drawing or equation (such as 18 = 10 + 8); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones.
K.G.6	Compose simple shapes to form larger shapes. For example, *"Can you join these two triangles with full sides touching to make a rectangle?"*
1.NBT.2	Understand that the two digits of a two-digit number represent amounts of tens and ones. Understand the following as special cases:
	• A 10 can be thought of as a bundle of ten ones—called a *ten*.
	• The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six, seven, eight, or nine ones.
1.G.2	Compose two-dimensional shapes (rectangles, squares, trapezoids, triangles, half-circles, and quarter-circles) or three-dimensional shapes (cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape, and compose new shapes from the composite shape.


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Despite the importance of composing and decomposing to the Standards and to the understanding of later mathematics, these ways of thinking mathematically are rarely highlighted by early childhood teachers, particularly in relation to play—where the emphasis tends to be on counting and shape identification, if mathematics is addressed at all (Parks and Bridges-Rhoads 2012; Ginsburg, Lee, and Boyd 2008). However, in play, children routinely compose and decompose physical objects and could be helped to recognize this shift in focus from the whole to the part as well as to begin to think about numbers and shapes in similar ways.

We drew the examples shared in this article from a yearlong study of a rural public preschool in Georgia, where nearly all children in the pre-K–grade 12 school received free lunch. About 90 percent of students in the school were African American; 9 percent were European American, and 1 percent were Hispanic. Looking across approximately 750 minutes of video recordings captured throughout the year, we found three common play contexts to be particularly rich sites for children's exploration of composing and decomposing: the block area, the puzzle table, and the doll corner.

Composing and decomposing in play

Below we describe the mathematics embedded in each of these contexts with the goal of helping early childhood teachers to recognize and to highlight similar mathematics in play.

The block area

In playing with blocks, children continually engaged in composing and decomposing. The sizes of various blocks in different sets supported children in relatively complex thinking about how to compose equivalent units. For example, one afternoon, Carter decided to build a road out of blocks, announcing his intention to no one in particular. Carter began by laying down a 6 × 3 inch block. He then put together four 3 × 1.5 inch blocks, choosing from dozens of blocks around him that had spilled from the tub. For the next road segment, he chose two 6 × 1.5 inch blocks, putting them side by side. He then used another 6 × 1.5 inch block and then two 3 × 1.5 inch pieces. Finally, he chose two 3 × 3 inch blocks for the last segment in the road.

The wooden blocks, which were designed to make many equivalent shapes possible, allowed Carter to experiment and practice with composing and decomposing shapes. Carter seemed to embrace this activity as part of his play. After all, several of the large 6 × 3 inch blocks were available, and Carter could have chosen to create a road out of identical blocks. Instead, he seemed to go out of his way to make as many equivalent combinations as possible in the building of his road. Moreover, he could have chosen to use units that were not equivalent, such as by lining up just two 3 × 1.5 inch blocks to add a square before adding another rectangle. However, this never happened.

Common play contexts are rich sites for children's exploration of composing and decomposing numbers.

Carter based his block constructions on a large unit and then experimented with ways that unit could be broken into smaller, but equivalent, pieces. This mental model could support children in thinking about numbers being broken apart in multiple ways. However, although the classroom teacher and paraprofessional did sometimes direct children's attention toward mathematics in the block corner, they focused almost entirely on counting and shape identification, such as by asking children to count the blocks in the tower or to identify a square or a rectangle. These mathematical concepts are important for young children as well—and are part of the Common Core—but long after counting to twenty and naming two-dimensional figures became routine for the children, teachers continued to focus only on these concepts.

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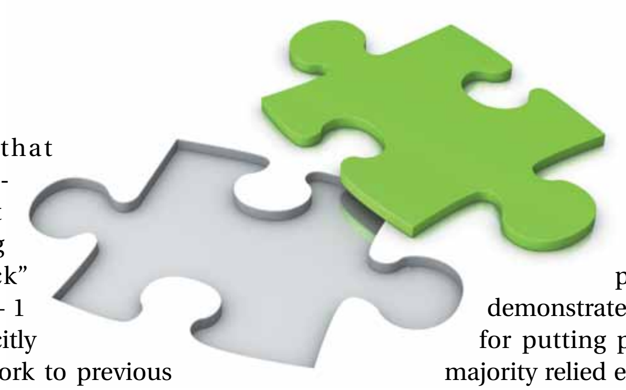
Carter seemed to go out of his way to make equivalent combinations instead of building his road of identical blocks or those that were not equivalent.

If appropriately expanded on, block play could also help young children build mental models for decomposing numbers, a skill they are expected to learn in kindergarten. Questions during play that ask students to compare the length of various blocks and to find relationships among them could direct children's attention toward the ways that smaller quantities make up larger quantities. For example, teachers could ask, "How many red blocks did you use to cover the green one?" In formal lessons, this thinking could be extended further. For example, Cuisenaire® rods provide a readily available set of blocks that are designed to emphasize number relationships. After free play with blocks, children could be invited to engage in centers or structured lessons that have them find the numerical relationships of these rods—such as discovering different ways to create the ten-unit rod with smaller units. Children who were ready could then write out number sentences to record these discoveries. Similar problems could be created with drawings or construction paper models that would allow children to experiment with decomposing a five-unit "brick" into "blocks" of 4 + 1 or 2 + 3. By explicitly connecting this work to previous play with blocks, teachers could help students draw on the prior knowledge they developed during play.



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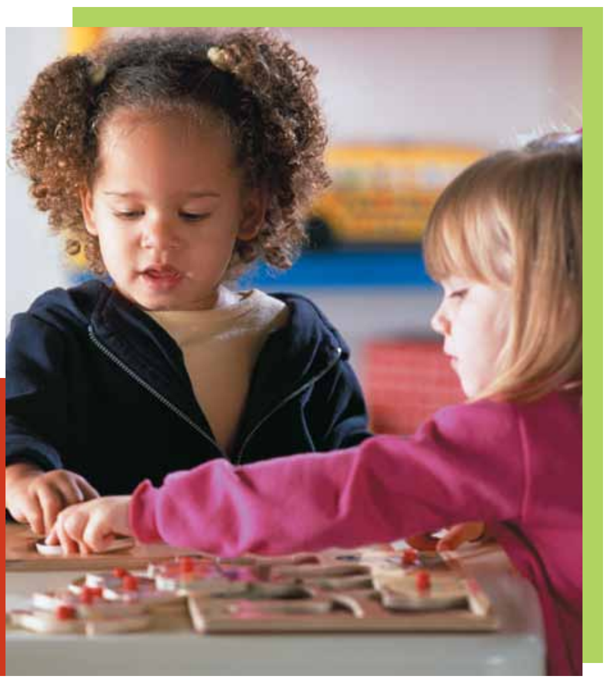
The puzzle table

After the block table, the puzzle table was the next most frequent context for exploring the ideas of composing and decomposing. In this classroom, the available puzzles were not the tangram-based or pattern block–based puzzles typically portrayed in early childhood mathematics curricula, but instead were commonly available children's puzzles. A few required each piece to be placed independently in the appropriately shaped hole, such as a farm puzzle with ten animal pieces, but most portrayed entire pictures that were cut apart into smaller pieces. Like construction in the block area, the act of creating a picture from smaller pieces and then breaking it down again provided an opportunity for students to build a conceptual map of the composing and decomposing process described in the Standards in relation to geometric shapes.

Most children who played with puzzles demonstrated one of two strategies for putting puzzles together. The majority relied exclusively on identifying the shape of the hole they were trying to fill and finding an appropriate piece for that hole, as Jakim did in the anecdote that opened this article. For the most part, when teachers intervened at the puzzle table, it was to reinforce this strategy by drawing students' attention to shapes and their orientations. This may have been why so many students relied on this strategy. However, the students who, by the end of the year, were most successful at quickly solving even unfamiliar puzzles, moved back and forth between the strategy of looking at the shape of individual pieces and the strategy of visualizing the entire picture and the relationship of a given piece to that picture. For example, Alisha picked up a yellow puzzle piece with flecks of green and tried to fit it into a space that seemed appropriate. When it did not fit, she stopped and looked at the piece and then ran her finger around the edge of the puzzle, stopping when she got to a section of green grass. She then re-oriented the piece to fit in a space in this section of the puzzle portraying grass and successfully inserted it. Similarly, when Calvin picked up a pink piece, he said "this is the flamingo" and moved it to the top of the puzzle to attach to the rest of the bird. In contrast, Janelle used trial and error to find the appropriate space for each piece, a strategy that took longer to achieve success and that seemed to result in greater frustration with the puzzle-solving process.

Treating the puzzle table as a site for instruction in addition to a site for play might allow students like Janelle to become more successful at solving puzzles, which might also encourage students like her and Jakim to do puzzles more often and develop greater competence. Rather than simply encouraging students to "keep trying," teachers could ask students to imagine what the completed picture looks like and to imagine in which part of the picture their chosen piece belongs. Students could also be encouraged to look for identifying details on particular pieces to connect the small part to



BRAND X PICTURES/THINKSTOCK

Composing a picture from puzzle pieces and then decomposing it offers youngsters a chance to build understanding of a key mathematical concept.

the greater whole. Naming the strategy of looking at the whole picture, in addition to matching shapes, would emphasize the importance in mathematics of moving fluidly between wholes and parts and would be likely to allow students to think about composing and decomposing various shapes later.

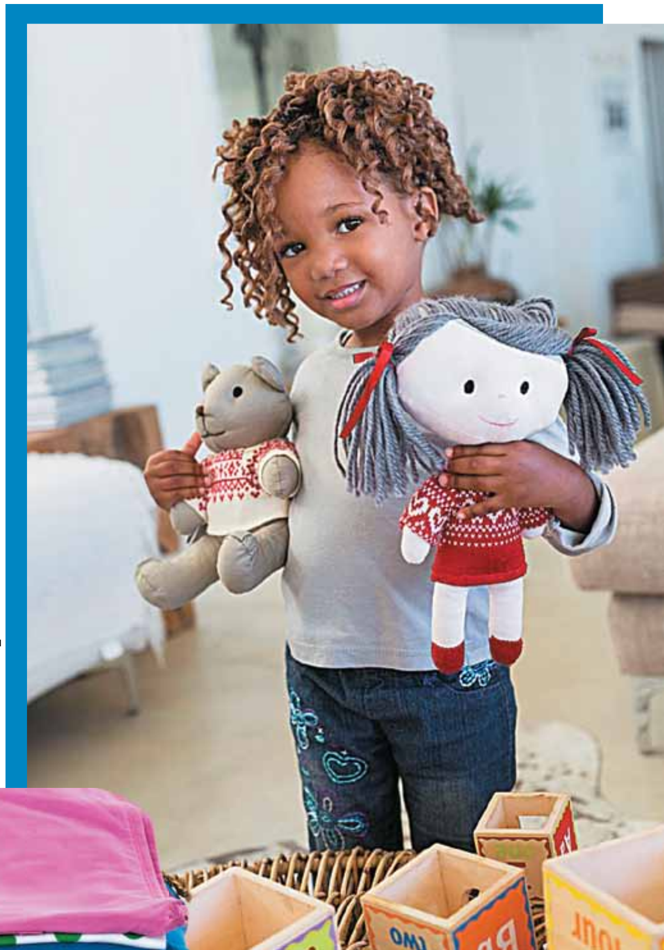
The doll corner

When we entered the preschool classroom looking for mathematics in play, we anticipated that certain materials (like blocks and puzzles) would be important areas of observation; however, we were surprised by the variety of mathematics we observed in the doll corner. For example, although unrelated to composing and decomposing, nearly all children who played in the doll corner engaged in proportional reasoning on a regular basis, as they chose doll clothes from a large basket to match to particular dolls.

The folding of doll clothes and blankets provided repeated opportunities to attend to decomposing shapes in particular ways and to attend to precision in the work. For example, one morning Alisha sat folding clothes and talking with her friends. She picked up a dress and folded it along its line of symmetry. As she picked it up to put it away, she noticed that the edges of the dress were not lined up perfectly. She then held up her hand to her friend to signal that she should stop talking, opened the dress, and refolded it, careful to ensure that the edges matched perfectly. Similarly, when Jamal was helping clean up in the doll corner, he picked up a blanket that had landed on the floor. Rather than simply stuffing it into the laundry basket, he held out his arms wide, grabbed the ends of the blanket, and folded it in half vertically and then horizontally, ensuring that the edges lined up in both cases.

In addition to attending to precision, children could learn to analyze shapes from doing these folding activities and could begin to build a conceptual foundation for later mathematical work around both symmetry and fractions. In particular, by folding clothes and blankets into precise halves and fourths, children had repeated opportunities to think about how various shapes could be decomposed into equivalent parts.

CLOTHES: HILMI_M/THINKSTOCK; GIRL WITH DOLLS: ONOKY PHOTOGRAPHY/VEER



Conversations and writing about mathematics in doll play are scarce, despite the opportunities to explore measurement, symmetry, and geometry.

Unlike work with blocks, puzzles, and even with crafts, teachers never intervened in the doll corner to direct children's attention toward available mathematics. This may have been because few opportunities existed for counting and shape identification in the doll corner and these were the primary mathematics content that teachers focused on in their conversations during play. Additionally, little has been written or talked about—even in conversations about mathematical play—regarding the mathematical concepts embedded in doll play. Recognizing the possible mathematics in these areas seems important, though, because these activities offered unique opportunities related to measurement and geometry and also because these areas were heavily (although not exclusively) populated with girls. Helping girls to see the mathematics embedded in their play may help them see themselves as people who are competent and interested in mathematics.

Getting smarter about designing structured mathematics

As we plan lessons for young children, we ought not allow the push toward formal curricula to reduce young children's already diminished opportunities to play, which have long been recognized as vital to not only children's intellectual and social development but also their very well-being (Copple and Bredekamp 2009; Piaget 1962; Vygotsky 1978). Additionally, play itself affords important opportunities for learning. For example, researchers have found that children who attended academically focused preschools were no more fluent with basic facts by first grade than were children who attended play-based schools. However, children from schools with few opportunities for play did less well on measures of creativity (Hirsh-Pasek, Golinkoff, and Eyer 2004).

TABLE 2

To recognize occasions for highlighting math in children's play, teachers must become familiar with the Common Core State Standards for Mathematics (CCSSM) (CCSSI 2010).

Ideas for highlighting composing and decomposing during play

Toys and materials	Examples of composing and decomposing during play	Questions and comments teachers can make to enhance students' play	Related CCSSM (see table 1)
Legos® and blocks	Using two triangles to make up one square Creating equivalent lengths with different blocks Counting blocks in structures and breaking them apart to make new, smaller structures Filling in an enclosure with blocks	"I see you used two triangles to create one square." "Are there any other shapes you can use to make a rectangle the same size as this one?" "How many little blocks did it take to make a tower the same size as the big one? Are there other ways you could make a tower that same size?" "Wow. I wonder how many little blocks it will take to fill up that whole space?"	K.OA.3 K.G.6 1.G.2
Puzzles	Finding where a piece of the puzzle fits into the whole puzzle Using the partial picture on a puzzle piece to help find where the piece belongs within the whole picture	"Look at the picture on the puzzle piece, what part of the puzzle does it look like it belongs to?" (Have students describe what they see: colors, etc.) "Can you find a piece of the elephant?"	K.G.6 1.G.2
Doll corner	Folding doll clothes and blankets in half, thirds, and fourths Decomposing an area along a line of symmetry	"You did a great job folding the dress in *half*." "Look, both parts of the blanket are the same size." "When you unfold the blanket, do you think it will look bigger or smaller than it is now?" "You were very careful folding that blanket so the edges matched perfectly. The two halves are exactly the same shape and size."	K.G.6 1.G.2

Recognizing the mathematics in play can serve an important role in balancing the two goals of increasing young children's mathematical experiences and of ensuring that they have ample time for independent exploration. However, as Ginsburg, Lee, and Boyd (2008) wrote, simply allowing students to engage in play is insufficient for the development of mathematical knowledge. By itself, play "does not usually help children to mathematize—to interpret their experiences in explicitly mathematical form and understand the relations between the two" (p. 7). Teachers, even of the youngest children, must become familiar with the mathematics presented in the Common Core State Standards—through conversations about the Standards and through talking about children's play in relation to them—so that they can recognize opportunities to highlight mathematics when they occur. The questions and comments suggested in **table 2** provide a start for this work. And as teachers begin to see and to build on children's mathematical play, they can again feel good about giving their students the concrete, exploratory experiences that children need to make real sense of mathematics' many abstractions.

REFERENCES

Copple, Carol, and Sue Bredekamp, eds. 2009. *Developmentally Appropriate Practice in Early Childhood Programs Serving Children from Birth through Age 8*. 3rd ed. Washington, DC: National Association for the Education of Young Children.

Ginsburg, Herbert P., Joon Sun Lee, and Judi Stevenson Boyd. 2008. "Mathematics Education for Young Children: What It Is and How to Promote It." In *Social Policy Report* 22 (1), edited by Lonnie Sherrod and Jeanne Brooks-Gunn, pp. 3–22. Ann Arbor, MI: Society for Research in Child Development.

Golinkoff, R. M., K. Hirsh-Pasek, and D. Eyer. 2003. *Einstein Never Used Flashcards: How Our Children Really Learn—and Why They Need to Play More and Memorize Less*. Emanus, PA: Rodale.

Graham, Theresa A., Cindy Nash, and Kim Paul. 1997. "Young Children's Exposure to Mathematics: The Child Care Context." *Early Childhood Education Journal* 25 (1): 31–38.

National Association for the Education of Young Children (NAEYC) and National Council of Teachers of Mathematics (NCTM). 2002. *Early Childhood Mathematics: Promoting Good Beginnings*. Joint statement of NAEYC and NCTM. http://naeyc.org/positionstatements/mathematics.

National Research Council (NRC). 2009. *Mathematics Learning in Early Childhood: Paths toward Excellence and Equity*. Washington, DC: National Academies Press.

Parks, Amy Noelle, and Sarah Bridges-Rhoads. 2012. "Overly Scripted: Exploring the Impact of a Scripted Literacy Curriculum on a Preschool Teacher's Instructional Practices in Mathematics." *Journal of Research in Childhood Education* 26 (3): 308–24.

Piaget, Jean. 1962. *Play, Dreams and Imitation in Childhood*. New York: Norton.

Vygotsky, Lev Semyonovich. 1978. *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

This material is based on work supported by the National Science Foundation (NSF) under Grant No. 844445. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of NSF .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