

Why Early Math Matters

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How Important Is Early Math?

We all know that math is important. But, how important is math in the early years when compared to other domains such as reading, attention, or socio-emotional development? It turns out that early math ability is the biggest predictor of later academic success at third and fifth grade.

How do we know this? It began with a look at six large-scale longitudinal studies of children in the United States, Canada and Great Britain. Dr. Greg Duncan at UC Irvine and colleagues (2007) analyzed these data to figure out which early skills at school entry were associated with later academic achievement. They controlled for variables known to affect children's academic performance such as socioeconomic status, mother's education, family structure and child health. In other words, their analyses separated out these factors so that all that remained was the actual predictive power of early math, reading, attention and socio-emotional skills on academic achievement. The results, as stated in the beginning of this column, demonstrated that early math skills were the strongest predictors of later

academic performance. (Reading was next, followed by attention. Socio-emotional behaviors were not statistically significant predictors.)

That was just the beginning. Researchers were so surprised that early math skills seemed so important that new research teams re-examined the findings. In 2010, the journal *Developmental Psychology* published five papers that confirmed the predictive power of early math skills.

Since then, other studies have looked at various aspects of the relationship between early math and later achievement. These subsequent studies continue to support the importance of early math skills. Researchers have found that children with persistent problems attaining math skills are less likely to graduate from high school or go to college, and that math achievement in adolescents actually predicts labor market success (Duncan & Magnuson, 2011). So, to answer the opening question, "How important is math in the early years when compared to other domains like reading, attention, or socio-emotional development?" Very.

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Common Core

Counting and Cardinality

- Know number names and the count sequence.
- Count to tell the number of objects.
- Compare numbers.

Operations and Algebraic Thinking

- Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.

Number and Operations in Base Ten

- Work with numbers 11–19 to gain foundations for place value.

Measurement and Data

- Describe and compare measurable attributes.
- Classify objects and count the number of objects in categories.

Geometry

- Identify and describe shapes.
- Analyze, compare, create, and compose shapes.

Helping Children Succeed in Mathematics

Exceptional teachers use their knowledge of individual children to meet them where they are developmentally and provide the support needed to sustain their progress. Research shows that by kindergarten many children already possess mathematical knowledge that is “surprisingly broad, complex and sophisticated” (Clements, 2004). But we also know that some children come to school with less advanced skills.

Instruction that is tailored to a child’s individual oral language and literacy needs results in the highest gains for that child (Connor et al., 2009). Does this apply to math instruction as well? To answer this question, researchers (Engel, Claessens & Finch, 2010) examined different types of mathematical instruction during the kindergarten year in a nationally representative sample of more than 7,000 children and 2,000 teachers in the United

States. The type of instruction made a difference. When instruction failed to meet children where they were in their mathematical development (for instance, teaching concepts children already knew such as basic counting and shapes), such instruction was associated with lower math achievement at the end of the kindergarten year. However, instruction in more sophisticated mathematical concepts such as those included in the Common Core State Standards in Mathematics predicted later mathematical achievement for these children. Importantly, for the five percent of children who had come into kindergarten without the basic skills of counting to ten and knowing the names of common shapes, instruction in basic content was beneficial. The lesson learned is that, like oral language and literacy, mathematics instruction that is targeted to children’s individual needs achieves the greatest benefits.

An Opportunity

Recently, an article in *Education Week* (Robelen, 2012) profiled districts charged with piloting the Common Core. Not surprisingly, many of these districts chose to begin implementation in the kindergarten year and then phase in implementation of the Common Core in later grades in subsequent years. Why? Kindergarten is the doorway to formal education and as such can set the trajectory for children’s learning for years to come. Implementing the Common Core in later grades may be difficult as children may begin the year without the prior knowledge necessary to benefit from the level of instruction outlined in the Common Core. The kindergarten teachers interviewed in these districts were excited and motivated because they felt that the Common Core presented an opportunity to provide a deeper foundation in early math skills than previously provided by broader, but shallower standards. Teachers also looked favorably upon the opportunity to “meet children where they are academically” and the availability of more time to gauge student understanding.



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Supporting Mathematical Thinking

The Common Core Mathematical Practices describe the type of expertise we seek to develop in our students. This begins in kindergarten. The Practices are listed below with descriptions of how we might conceptualize children's engagement in the kindergarten classroom.



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Mathematical Practices

1. Make sense of problems and persevere in solving them.
 2. Reason abstractly and quantitatively.
 3. Construct viable arguments and critique the reasoning of others.
 4. Model with mathematics.
 5. Use appropriate tools strategically.
 6. Attend to precision.
 7. Look for and make use of structure.
 8. Look for and express regularity in repeated reasoning.
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Make sense of problems and persevere in solving them. Children should be engaged in sense-making mathematics. Knowing that two plus two equals four is important, but understanding how addition fits into problem solving in the real world is where the rubber hits the road. Also, problems that are too easy are not useful. Children need to learn how to persist in problem-solving. Problems aren't *problems* if they are resolved upon viewing.

Reason abstractly and quantitatively. Initially, children reason with quantities in a very concrete way: "If I can have three crackers for snack, and I've already eaten two, that means that I can only have one more." Later, children learn that these sorts of quantity questions can relate to numbers themselves in a more abstract way, for example, that one plus *any* whole number equals the next number. Likewise, children can use number words and the terms *more* or *less* to describe differences between two sets of teddy bears.

Construct viable arguments and critique the reasoning of others. It isn't enough to get the right answer or to tell someone else that their answer is wrong. Young children must begin to grapple with why an answer is correct or incorrect. Conversations that highlight how children solved problems and include discussion of alternative solutions can help children to build their repertoire of problem-solving strategies. Similarly, understanding what went wrong can contribute to children's understanding of how to approach similar problems in the future.

Model with mathematics. Eventually, young children learn that problems can be modeled mathematically. This means that figuring out how many children are in the class altogether can be modeled by an equation that includes the number of girls, a plus sign, the number of boys, and an equals sign.

Use appropriate tools strategically. Which tools does one use to measure weight? Height? Temperature? All of these questions are appropriate and useful for young children. Estimation is another tool. For example, if a child adds five and two together and gets ten, ask if the answer should be a lot more than five or a little more than five. Children can use fingers or manipulatives to illustrate their thinking.

Attend to precision. Math is all about precision. After all, using a minus sign instead of a plus sign or the numeral 6 instead of the numeral 5 completely changes both the question and the answer! Or, in precise terms, it changes the equation. Children come to understand that, like changing the *c* in *cat* to an *m* changes the noun from something that can walk on you to something that you can walk on, changing numbers alters the equation.

Look for and make use of structure. Young children look at structure early ("Look, I have black and white stripes just like Leah!"), finding patterns in both the environment and in mathematics ("I know, I know! One plus any number is just the next number!"). Our job is to ensure that they continue to look at the structure of mathematics in an increasingly sophisticated way. Four trucks plus three trucks is the same amount as three trucks plus four trucks. Children should be provided with opportunities to see structure in mathematics every day.

Look for and express regularity in repeated reasoning. Can young children really do this? Yes! Even the aforementioned understanding that one plus a number equals the next number in the counting sequence is representative of regularity in repeated reasoning. Young children may begin to understand that, for whole numbers, multiplication is repeated addition. (This doesn't work for fractions though! Think about $\frac{1}{2}$ multiplied by $\frac{1}{2}$).

What About Activities?

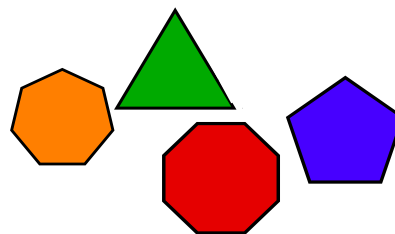
Included below is an mathematical activity for the playground. Several areas from the Common Core are covered: *Counting and Cardinality*, *Operations and Algebraic Thinking*, and *Geometry*. Scaffolding for both less and more advanced children is included.



Musical Shapes

Materials Needed:

Playground
Large Chalk
CD/Tape Player
Music CD/Tape



1. This game is a rendition of Musical Chairs, except there are no chairs and no losers!
2. Count the number of children in your class.
3. While on the playground, draw shapes whose sides total the number of children in your class (if you have 15 children, you could draw five triangles, or three pentagons, or an octagon and a septa/heptagon... you get the picture). These shapes should be able to hold the same number of standing children as there are sides without undue crowding. Try to draw polygons with equilateral sides (sides of the same length).
4. Provide instructions to the children:
 - Walk around the shapes with the children and have them name the shapes and count the sides.
 - Before you leave each shape, ask children to count the sides and put the same number of children inside the shape. Make sure children understand this part: **# of sides = # of children**
 - Explain that when you start the music, children should begin walking around the shapes, without going inside them. When the music stops, the children should fill the shapes—but only with the same number of children as sides.
5. Start the music (best to start with a slow song). Play for about one minute. When you stop the music, remind the children to match the number of shape sides with the number of children. Initially, the children will need a lot of help organizing themselves into the shapes appropriately. Starting with simpler shapes or identical shapes (all triangles) may help.
6. Repeat game as desired!

Scaffolding Down

For children who have difficulty initially grasping the game—consider writing the number of sides in a shape in the shape itself. However, as soon as children understand the game, remove these numerals so that they need to analyze the shape in order to figure out how many children should stand inside.

Scaffolding Up

For children who easily grasp the game, consider involving them in calculating which shapes should be drawn. Later in the school year, this can be a whole class activity that involves children's composition/decomposition and addition/subtraction skills in determining what combination of shapes can be used to provide exactly the right number of sides for the class.

Rainy Days

Consider marking the shapes on the floor inside the classroom with masking tape.

Conclusion

There is considerable evidence that early math skills predict later academic success. Providing instruction that enables children to build a foundation of early math skills can help preclude persistent problems in mathematics, and that can help ensure that children go on to college and set the stage for later success in the labor market. Kindergarten teachers are uniquely positioned to guide young children on this path.



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...The science of pure mathematics, in its modern developments, may claim to be the most original creation of the human spirit.

Alfred North Whitehead (1925)

About the Author

Linda M. Platas holds a Ph.D. in Education from the University of California at Berkeley and a B.A. in Child and Adolescent Development. Her primary areas of research are early mathematical development and teacher beliefs. Early in her career, she worked directly with young children and families. Her experience includes work on preschool math interventions, professional development in early language and literacy, and elementary school math curriculum. She is a member of the Early Childhood Education Advisory Committee, San Mateo County College District. Linda also serves on the Expert Panel that developed the Early Grades Math Assessment (EGMA), which is currently being used by the World Bank and USAID in multiple African nations. She is currently a consultant to the Heising-Simons Foundation, advising in the area of early mathematics. She can be reached at lplatas@berkeley.edu.

- Clements, D. (2004). Engaging Young Children in Mathematics: Major Themes and Recommendations. In D. H. Clements & J. Sarama (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics* (pp. 7-72). Mahwah, NJ: Lawrence Erlbaum Associates.
- Connor, C. M., Piasta, S. B., Fishman, B., Glasney, S., Schatschneider, C., Crowe, E., Underwood, P., & Morrison, F. J. (2009). Individualizing student instruction precisely: Effects of child by instruction interactions on first graders' literacy development. *Child Development, 80*(1), 77-100.
- Duncan, G. J., Claessens, A., Huston, A. C., Pagani, L. S., Engel, M., Sexton, H., . . . Japel, C. (2007). School readiness and later achievement. *Developmental Psychology, 43*(6), 1428-1446.
- Duncan, G. J., & Magnuson, K. (2011). The nature and impact of early achievement skills, attention skills, and behavior problems. In G. J. Duncan & R. J. Murnane (Eds.), *Whither opportunity: Rising inequality, schools, and children's life chances* (pp. 47-69). New York, NY: Russell Sage.
- Engels, M., Claessens, A., & Finch, M. (2011). *Teaching students what they already know? The misalignment between mathematics instructional content and student knowledge in kindergarten*. Paper presented at the American Educational Research Association Annual Meeting, New Orleans, Louisiana.
- National Governors Association Center for Best Practices, Council of Chief State School Officers. (2010). *Common Core State Mathematics Standards*. Washington D.C.: National Governors Association Center for Best Practices, Council of Chief State School Officers
- Robelen, E. W. (April 25, 2012). Big shifts ahead for math instruction. *Education Week, 31*(29), 24-30.

**For
Further
Reading**