Purpose: Resource for local leaders when considering what questions they should ask and supports they can provide to support early learning.

Connection to the myFutureNC Strategic Plan: Academic Readiness

A STRONG START FOR FUTURE ATTAINMENT: EARLY MATH

Why Early Math Matters, and What Families and Communities Can Do to Support It

Why Early Math Matters for Success in High School and Beyond

While there are many steps in a child's growth trajectory from the early years through high school, research has shown early math development to be an important predictor (along with language and attention development) of later academic success. Differences in mathematics knowledge and skill are detectable even before children enter kindergarten and can persist throughout formal schooling.[1] Elementary school students with persistent problems in mathematics are 13% less likely to graduate from high school and 29% less likely to attend college.[2] Importantly, early math skills also are a better predictor of 8th grade academic success than reading scores—regardless of race, gender, or socioeconomic status.[3]

Math matters for future employment and earning success as well. A recent analysis of the best-paying entry-level jobs for students graduating from college reveals that the top base salaries typically are in STEM (Science, Technology, Engineering and Math) fields, such as computer science and information management, engineering, nursing, and finance. In North Carolina, entry-level programmers with a college degree earn between $55,000 and $100,000 as a base salary.[4] New software engineers with a college degree begin at Apple or Google with starting salaries in excess of $130,000.

Skills sought by contemporary employers require a strong foundation in math that begins very early in life and continues throughout a student's school experience. These skills also include problem-solving, reasoning capacity, and the ability to communicate verbally and in writing,[5] all of which are a part of math development. Yet many students in North Carolina and across the nation move through elementary, middle, and high school with significant gaps in mathematics knowledge and skills:

- Nearly 70% of students entering community college and 40% of those entering four-year institutions require remedial math[6]

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[1] ibid
[2] Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L. S., Feinstein, L., Engel, M., BrooksGunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. Developmental Psychology, 43(6), 1428–1446. https://doi.apa.org/doiLanding?doi=10.1037%2F0012-1649.43.6.1428
[3] The Impact of Early Math and Numeracy Skills on Academic Achievement in Elementary School, Northwest Commons, 2019 https://nwcommons.nwciowa.edu/cgi/viewcontent.cgi?article=1145&context=education_masters
[4] Entry Level Programmers, North Carolina, Glassdoor. Retrieved February 2022 https://www.glassdoor.com/Job/north-carolina-entry-level-programmer-jobs-SRCH_IL.0,14_IS1282_KO15,37.htm
[5] Karadimos , M. Why Must I Learn Math, Math Guide, November 2020. http://www.mathguide.com/issues/whymath.html
[6] Why We Funded Two Communities that Bring Family Math to Life, Overdeck Foundation, August 2019 https://overdeck.org/news-and-resources/article/why-we-funded-two-communities-that-bring-family-math-to-life/

- On the 2019 National Assessment of Educational Progress, only one in three North Carolina 4th and 8th graders demonstrated proficiency in math[7]
- On the 2021 North Carolina End-of-Grade mathematics test, just 24% of 3rd through 8th graders earned a "college- and career-ready" math score[8]

There are also important differences by income, geography, and race on North Carolina students' math accomplishment:

- Students in rural North Carolina communities score lower than urban and suburban students, and scores for non-white students typically lag behind scores for white students[9]
- Only 10% of North Carolina students enrolled in the Free or Reduced-Price Meal Program score at the college-and career-ready level in math[10]

Just as building a solid house requires a solid foundation and structural integrity for each floor above it, success in school, at work, and in life depends on solid early math development, with knowledge and skills added and practiced at each period of children's growth.

What We Know about Early Math Learning

Math Skills and Knowledge at Entry to Kindergarten

To help families strengthen their children's earliest math experiences, the North Carolina Department of Public Instruction has developed a guide to math skills expected at kindergarten entry:[11]

- Count to 20
- Count a small group (up to 10 objects), point to each, and tell how many there are in all
- Instantly recognize how many objects are in a smaller group (three or less) without counting
- Identify which groups have more or less
- Recognize patterns, shapes, and order (first, next, and last)
- Begin to write numerals (one to five)
- Begin to answer questions like "How many do we need?" via counting and observation.

The National Association for the Education of Young Children has identified additional essential math skills expected at kindergarten entry,[12] including:

Number Sense	• Sort and classify objects into sets according to size, color, shape, quantity, etc. • Match objects using one-to-one correspondence • Understand estimation terms such as *more*, *fewer* or *the same* • Understand location/position terms such as *inside*, *outside, top*, and *bottom* • Recognize and write the numbers 1 to 10
Measurement	• Understand measurement terms such as *big/small*, *light/heavy*, and *more/less* • Arrange two or more objects according to size
Spatial Sense & Geometry	• Understand and use spatial terms such as *in/out*, *bottom/top*, and *above/below*

[7] NAEP Report Card: 2019 NAEP Mathematics Assessment, The Nation's Report Card, 2012. https://www.nationsreportcard.gov/highlights/mathematics/2019/g12/ and https://www.nationsreportcard.gov/highlights/mathematics/2019/
[8] College and Career Ready in Math, myFutureNC, 2021 https://dashboard.myfuturenc.org/academic-readiness/college-and-career-ready-in-math/
[9] ibid
[10] ibid
[11] ibid
[12] Mathematics Milestones, National Association for the Education of Young Children, April 2020 file:///C:/Users/janice/Downloads/Mathematics%20milestones.pdf

	• Identify and sort two-dimensional shapes (e.g., *circle*, *square*, *triangle*)
Patterning	• Arrange sequences based on changing colors, sizes, or shapes
Data Management & Probability	• Compare objects using two features such as *rough/smooth* or *big/small* • Understand and use probability terms such as *more likely* or *less likely* based on personal experiences (e.g., chance of participating in a particular activity) • Sequence numbers in order

Getting There: Mathematics Learning before Kindergarten

As parents, caregivers, and preschool teachers know, this skill set does not magically emerge at the age of five. It begins in infancy and develops within the context of simple interactions between very young children and the people and objects in the world around them. Talk, touch, eye-to-eye contact, bathing, singing, reading, and rocking are all parent-child interactions that provide the context for cognitive and emotional learning, language and, yes, math.

> *Becoming good at math begins long before a child enters school. Each of us is born to be a math person.*
>
> Economist Ron Ferguson
> Harvard Kennedy School

When parents or other caregivers name and then sort, order, and compare objects in ways their children can see and hear, early mathematical concepts are born.[13] This experience sometimes is called *math talk*, and through these exchanges, very young children "develop spontaneous, informal, and often preverbal ideas of more and less, big and small, pattern and position."[14]

Adult and Societal Challenges Impact Early Math Learning

For some families, health, housing, safety, and economic challenges can negatively affect the tone and frequency of these early parent-child interactions.[15,16] These challenges rob young children of the opportunity for "spontaneous concepts gained in everyday experience to grow upward to scientific concepts of early mathematics."[17] In fact, research suggests that fewer than 10% of children living in low-income circumstances can count to 20 at entry to kindergarten,[18] and that many arrive at kindergarten with millions fewer words than their economically advantaged peers.[19]

Young children also pick up on their parents' beliefs about math. Some of these parental beliefs about math could themselves serve as a negative impact on their children. For example, some parents believe that math is less relevant than reading for success, or that the responsibility for math learning should fall exclusively on the schools.[20]

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[13] Building STEM (Science, Technology, Engineering, & Math) Skills from Birth, Zero to Three, May 2017 https://cdn.coverstand.com/45474/424196/183a0faeee47de7def4dbabcc0b4df3037c0e4ad.pdf
[14] Nurturing Mathematical Thinkers from Birth: The Why, What and How. Building STEM (Science, Technology, Engineering, & Math) Skills from Birth, Zero to Three, May 2017 https://cdn.coverstand.com/45474/424196/183a0faeee47de7def4dbabcc0b4df3037c0e4ad.pdf
[15] Nurturing Mathematical Thinkers from Birth, op cit
[16] What Causes the Word Gap? Financial Concerns may Systematically Suppress Child-directed Speech, National Library of Medicine 2020 https://pubmed.ncbi.nlm.nih.gov/34240510/
[17] Nurturing Mathematical Thinkers from Birth, op cit
[18] Commentary: Parents Read to Their Kids. Why Not Do Math Together? New Project Looks to Promote Family Math — and Help Close the Achievement Gap, The 74, April 2018 https://www.the74million.org/article/commentary-parents-read-to-their-kids-why-not-do-math-together-new-project-looks-to-promote-family-math-and-help-close-the-achievement-gap/
[19] The Word Gap: The Early Years Make the Difference, National Association for the Education of Young Children, February-March 2014 https://www.naeyc.org/resources/pubs/tyc/feb2014/the-word-gap
[20] School Daze: Average parent is no better at math or science than a 6th grader! Study Finds, September 2020 https://www.studyfinds.org/average-parent-math-science-sixth-grader/

Research also shows that parents' feelings of discomfort with their own math knowledge (sometimes described as *parental math anxiety*) can be adopted by their children.[21] When students bring these attitudes and anxiety with them to school, the result is lower levels of math learning. [22, 23]

Actions Families Can Take to Support Children's Early Math

1. Learn How to Track Your Young Child's Development

Download and regularly use a free developmental screening tool, like the Center for Disease Control's Milestone Tracker App. If you see signs that your child's early math development lags behind expected developmental milestones, or if your child has special needs such as a delay in learning to talk, talk to your pediatrician. Also take advantage of North Carolina's Infant-Toddler Program, which can help refer you to a local early intervention service. This program also offers free resources to families, in English and Spanish, including a resource directory and a developmental milestones chart. In addition, there are 17 Children's Developmental Service Agencies across the state that support families at the community level.

2. Make Time for Positive Math Interactions with Your Child

A free web video series, The Basics, provides many examples of ways parents can promote early brain development through intentional interactions with their infants and toddlers. For example, reading stories with rhymes, repetition, and numbers helps young children—even babies—learn basic math. When they are toddlers, use shape and color words and objects to help them compare, organize, and order. Name everything inside and outside and talk about its characteristics—and give your child an opportunity to respond by telling you what they see. Math happens everywhere.[24] The website also includes tips and resources for parents and community members.

3. Access the Free Online Family Math Activities and Resources

Make It Math, the Family Math Leadership Toolkit includes concrete information for parents to build everyday math knowledge for their children at home and when they are out and around in their community. These two resources include wonderful activities, checklists to track development, and other resources for parents.

In addition, the Erikson Institute has organized a rich family math library with many resources for promoting math concepts in children's earliest years. Examples of these resources include kitchen math, math with the birds, and best books for babies "to find math in their world."

4. Ask and Observe How Your Childcare and Preschool Program Promotes Early Math

After you have spent a little time with the resources above, take the ones you feel most comfortable with to your childcare provider or preschool program and ask them these questions: How do you

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[21] Math Anxiety: A Review of its Cognitive Consequences, Psychophysiological Correlates, and Brain Bases. Cognitive *Cogn. Affect. Behav. Neurosci.* doi: 10.3758/s13415-015-0370-7; For example, in a recent survey, 65% of parents did not remember math being "so hard" when they were in school, in part because, they said, math is "…taught so differently now" (Math Homework is Harder and More Confusing Than Ever Before, Study Finds, January 2021 https://www.studyfinds.org/math-homework-harder-for-parents/)

[22] Parents' Beliefs about Math Change their Children's Achievement, You Cubed, undated https://www.youcubed.org/evidence/parents-beliefs-math-change-childrens-achievement/

[23] Kids Benefit when Parents Overcome Math Anxiety, UChicago News, December 2018 https://news.uchicago.edu/story/kids-benefit-when-parents-overcome-math-anxiety. For example, children with "…poor attitudes toward math rarely performed well in the subject, while those with strongly positive attitudes had a range of math achievement" (https://www.sciencedaily.com/releases/2018/01/180124131736.htm)

[24] Help Your Child Develop Early Math Skills, Zero to Three. Retrieved February 2022 https://www.zerotothree.org/resources/299-help-your-child-develop-early-math-skills#chapter-209

organize the space to make early math activities likely? How do you measure my child's progress in early math? What can I do to help reinforce this early math learning at home?

5. Volunteer for and Support Community-Hosted "Make Math Real" Events

Partner with your local preschool and elementary school teachers to support at least one annual *Make Math Real* event or challenge. This may include, for example, hosting in-class or virtual visits by "Math Mamas" and "Math Papas," during which parents share with children how they use math at their jobs and at home. In addition, explore and promote "family math" activities that are available for free in the *Make It Math: Family Parent Leadership Toolkit* and via the Family Math Practice Network.[25]

Actions Community Leaders Can Take to Support Early Math

1. Sponsor Annual Community-Wide Activities that Promote Math

Build community engagement around one or more local, national, or international events that can promote math skills and enthusiasm. Used creatively, these opportunities can promote math in public spaces. For example, host a Lego challenge at the local library, a local business, or town hall for International Lego Day (every January 28th). Invite children to build and fly their homemade airplanes in a community space for National Paper Airplane Day (every May 26th). Partner with the local library or service organization to host a screening of classic family movies that feature math, like *Back to the Future* for Pretend to be a Time Traveler Day (every December 8th). Work with your local NC Smart Start partnership to develop community math events that include a focus on young children and take place outside of formal school and childcare settings.

2. Partner with Local Public Schools to Host Exploration of 1st Grade Math Standards

The North Carolina Department of Public Instruction has published a guide for teachers on first grade math standards. Partner with your local or county school district to host an evening conversation about these standards so that they become meaningful for more parents of kindergarten and first grade students.

3. Review Math Readiness Across Preschool, Kindergarten, and 1st Grade

Host an annual gathering and review of data from preschool, kindergarten and 1st grade math and reading assessments. Include parents and pre-Kindergarten, Kindergarten, and 1st grade teachers, and suggest how teachers, administrators and parents can, together, boost math readiness at home, at play and at school.

myFutureNC appreciates the support from The Belk Foundation to produce these special reports.

[25] https://nafsce.org/page/FMPracticeNetwork