Nurturing Young Mathematicians

Full-Day Kindergarten Implementation and Planning Conference

Hilton Eugene
Eugene, OR
February 26, 2015

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Office of Superintendent of Public Instruction
Early Numeracy 'Champion'

How we will spend our time ~

- Reviewing what we know about early numeracy from research and practice
- Delving into fundamental early numeracy concepts
- Becoming aware of resources that WA uses in its P – 3 initiatives

What we know

What can children learn?

Cognitive research shows that “nearly from birth to age 5, young children develop an extensive **everyday mathematics** – including informal ideas of more and less, taking away, shade, size, location, pattern, and position – that is surprisingly broad, complex, and sometimes sophisticated.” NAEYC

Ginsburg, H.P., Lee, J.S., & Boyd, J.S. (2008). Mathematics education for young children: What it is and how to promote it. *Social Policy Report*. Society for Research in Child Development.

Mathematics Learning in Early Childhood: Paths Toward Excellence and Equity

National Research Council, 2009

The committee found that, although virtually *all* young children have the *capability* to learn and become competent in mathematics, for most children the potential to learn mathematics in the early years of school is not currently realized. This stems from a lack of opportunities to learn mathematics either in early childhood settings or through everyday activities in homes and in communities.

Kindergarten Skills and Behaviors

	Achievement (reading, math)	Engagement	Problem Behaviors (Anti-social, mental health)
Description:	Concrete math and reading skills	Ability to control impulses and focus on tasks	i) Ability to get along with others ii) Sound mental health
Example test areas or question wording:	Knowing letters and numbers; beginning word sounds, word problems	Can't sit still; can't concentrate; score from a computer test of impulse control	i) Cheats or tells lies, bullies, is disobedient at school ii) Is sad, moody

Effects of school-entry skills and behaviors on later achievement

Reading Math Engagement

Anti-Social Mental Health

Skills and Behaviors	Predictive Power
	Greatest predictive power
	Least predictive power

Effects of school-entry skills and behaviors on later achievement

Reading Math Engagement

Anti-social Mental health

Skills and Behaviors	Predictive Power
Mathematics	Greatest predictive power (~ 35)
Reading	(~ 17)
Engagement	(~9)
Anti-social	(~1)
Mental health	Least predictive power (~0)

School Readiness and Later Achievement

Duncan, et al, Developmental Psychology, 2007

The strongest predictors of later achievement are school-entry math, reading, and attention skills. *Early math skills have the greatest predictive power*. By contrast, measures of socio-emotional behaviors were generally insignificant predictors of later academic performance, even among children with relatively high levels of problem behaviors.

Effects of K-5 skills and behaviors on completed schooling

Reading Math Engagement

Anti-social Mental health

Skills and Behaviors	Predictive Power

Effects of school-entry skills and behaviors on later achievement

Reading Math Engagement

Anti-social Mental health

Skills and Behaviors	Predictive Power
Mathematics	Greatest predictive power (~ 25)
Reading	(~ 16)
Anti-social	(~15)
Anxiety	(~10)
Attention	Least predictive power (~6)

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Kindergarten student mastery vs. time spent teaching

	Mastery by Fall K	
Basic Counting & Shapes	95%	
Addition & Subtraction	7%	
	11,517 students	2,176 teachers

Kindergarten student mastery vs. time spent teaching

	Mastery by Fall K	Mean Days/Month Spent Teaching
Basic counting & shapes	95%	12.70
Addition & subtraction	7%	4.38
	11,517 students	2,176 teachers

A Missed Opportunity: Mathematics in Early Childhood

Henry Kepner, NCTM Summing Up, February 2010

Prior to kindergarten, many children have the interest and capacity to learn meaningful math and acquire considerable mathematical knowledge. Many early childhood programs do not extend children's mathematical knowledge. Instead, they have these young students repeat the *same tasks in varied settings without posing challenges that would push them to the next level.*

A young child's brain

Brains develop most when challenged with complex, novel activities and not rote learning.

Preschoolers do not perceive situations, problems or solutions the same way adults do.

Young children see the world through an integrated lens, not as separate subject areas.

Adapted from Sousa (2008) *How the Brain Learns Mathematics*

Engaging in Complex Tasks

Engagement by parents with children on more complex math activities was positively related to their children's Quantitative Concepts scores (Woodcock-Johnson) where as basic numeracy activities were negatively related to pre-schoolers' Quantitative Concepts scores.

- LeFevre, J.; Skwarchuck, S.; Smith-Chant, B. L.; Fast, L.; Kamawar, D.; Bisanz, J. (2009). Home numeracy experiences and children's math performance in the early years, *Canadian Journal of Behavioural Science, 41(2),* 55-66.

The Basic vs Complex Tasks

Basic

- The counting sequence
- 1-1 correspondence

Complex

- Comparing quantities
- Working with operations

Engaging in Complex Tasks

What is taught may not meet the needs of many kindergartener.

Closer attention to entry-level kindergarten skills are needed.

Increase in time spent on more advanced topics could lead to gains in mathematics achievement.

Students who are not challenged, lose ground during kindergarten.

Considerations of Rich Tasks

Curriculum, if one is used

Pacing guides that do not fit the needs of children

Lack of training in numeracy development

Availability of rich tasks at educator's fingertips

Developmental continuum

As early as 9 months, children can discriminate sets of different sizes.

As early as 18 months, children begin to recognize shapes and develop systems for locating objects in space.

From ages 2-3, children can understand basic plus/change situations.

Adapted from the National Research Council (2009)
Mathematics Learning in Early Childhood: Paths Toward Excellence and Equity

Did Piaget get it right?

Tabula rosa is not true for mathematics

Piaget believed:

- children did not possess number sense and were unable to grasp the concept of number conservation
- children had no conceptual understanding until seven or eight years of age

Result: Delay in teaching mathematics until ages six or seven

Mathematics Education for Young Children: What It Is and How to Promote It

Ginsburg, Lee, & Boyd, Society for Research in Child Development, 2008

Cognitive research shows that young children develop an extensive everyday mathematics and are capable of learning more and deeper mathematics than usually assumed.

Typically, early childhood educators are *poorly trained* to teach mathematics, are *afraid of it*, feel it is *not important* to teach, and typically teach it badly or not at all.

Learning environment helps is important

- Classroom lends itself to mathematical exploration
- Student are engaged through a variety of instructional strategies
- Activities are conducted that rely on mathematics
- Children are asked higher-order questions
- Teacher is an observer of where child is in learning

Sousa/Clements

Importance of number talk

Teacher who use more number vocabulary when they talk (when controlled for general teacher quality, complexity of teacher's sentence structure, or the students' socioeconomic status) significantly impact the growth of children's conventional math knowledge over a year.

Klibanoff, Levine, Huttenlocher, Vailyeva, & Hedges, 2006

Teaching number sense

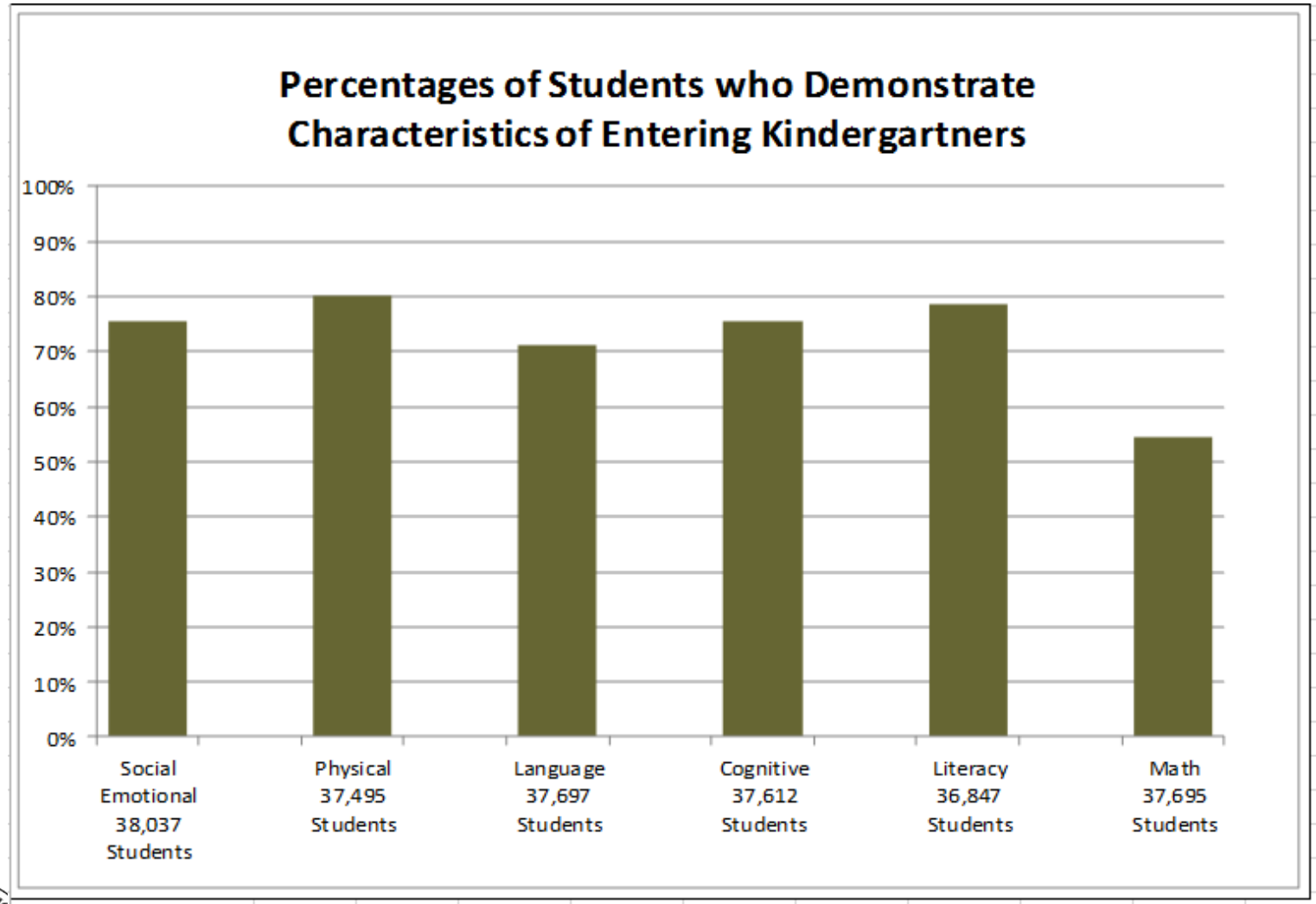
- Pair numbers with meaningful objects
- Use language to gradually match numbers with objects and symbols
- Incorporate counting activities
- Provide experiences with number lines.
- Introduce materials that involve numbers or number representations
- Read literature that involves numbers.

Sousa/Clements

Summary

- Early math is surprisingly important and children can learn much about mathematics early in their lives than previously realized.
- Math is also highly predictive of later achievement and schooling
- Early math instruction is geared toward skills children already know
- Teaching number sense is enhanced by the learning environment, number talk, and the activities children do

WaKIDS data


Percentages of Students who Demonstrate Characteristics of Entering Kindergartners
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Social Emotional 38,037 Students
Physical 37,495 Students
Language 37,697 Students
Cognitive 37,612 Students
Literacy 36,847 Students
Math 37,695 Students

Putting Research into Practice

WASHINGTON APPROACH

Key CCSS Shifts

Focus - Significantly narrow the scope of content and deepen how time and energy is spent in the math classroom.

Coherence - Carefully connect the learning within and across grades so that students can build new understanding onto foundations built in previous years.

Rigor - The CCSSM require a balance of:

- Solid conceptual understanding
- Procedural skill and fluency
- Application of skills in problem solving situations

Content Focus By Grade - Kindergarten

Key: ■ Major Clusters; ◘ Supporting Clusters; ○ Additional Clusters

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 measureable attributes.**
- ◘ **Classify objects and count the number of objects in categories.**

Geometry

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

http://www.k12.wa.us/CoreStandards/pubdocs/K-2clusters.pdf

P-3 Approach in Washington

New early learning guidelines

State-funded, full-day kindergarten is part of basic education *(RCW 28a.150.220)* -

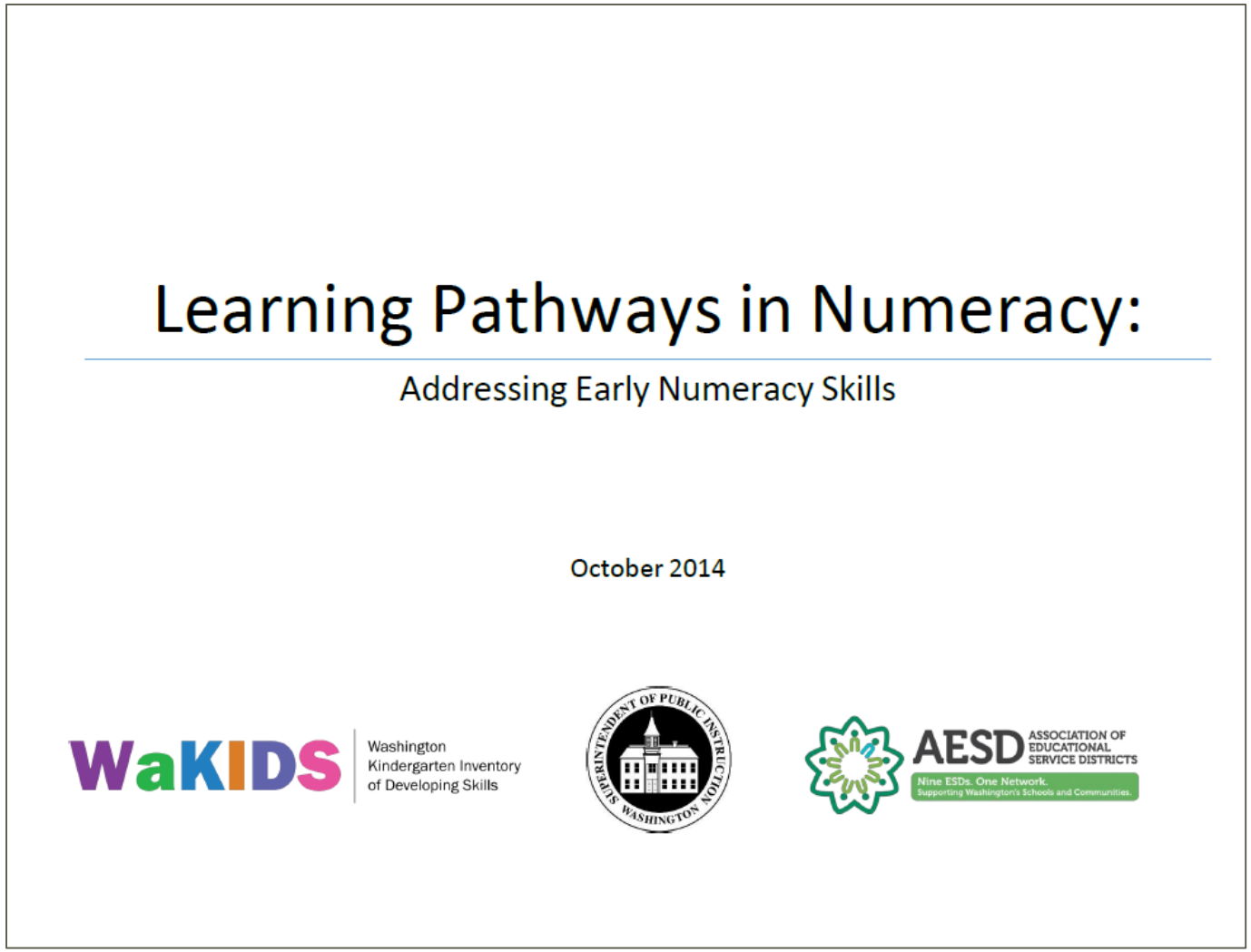
By 2017-18, all schools will have state-funding for full-day kindergarten *(RCW 28A.150.315) – 2007-2008*

WaKIDS data – inventory based on observation

Introduction of the Common Core

Learning Pathways in Numeracy:

Addressing Early Numeracy Skills



Learning Pathways for Counting and Cardinality

Learning Pathways for Counting and Cardinality

Counting and Cardinality

	Counting	ELG	TSG	Subitizing	ELG	TSG	Comparing and Ordering	ELG	TSG
0 – 36 months	• Imitate rote counting using some names of numbers. • Rote counts to 5, may be incorrect beyond this. • Rote counts to 10 • Keep 1-1 correspondence for 5 or less objects in a line. Beyond this may count quickly at the end if knows more numbers than objects, or recycles words if number of objects is greater than numbers known by rote. ₅	9-18m 16-36m 16-36m	20a O 20a Y 20a Y	• Demonstrate understanding of the concepts of *one, two,* and *more.* • Recognize and name the number of items in a set of two or three.	16-36m	20b OY	• Understand the idea of "more" related to food or play. • Put objects in 1-to-1 or 1-to-many correspondence. ₅ • Know more/less for very small collections of items, or with big differences in number of items. • Use comparison words • Compare collections of 1 – 4 items if the collections are made up of the same objects. ₅	9-18m 9-18m 16-36m	22 OYG
3 – 4 years	• Count to 10 or beyond. • Have cardinality for 5 or less objects. • Count out 5 objects	3-4 3-4	20c GB	• Instantly recognize and name the number of items in a set of three to four. • Make a small collection with the same number as another collection.	3-4		• Use gestures or words to make comparisons. • Compare groups of 1 -5 by matching or counting when objects in each group are about the same size. • Accurately count two equal collections, but when asked, says the collection of larger objects has more. ₅	3-4	
4 – 5 years	• Count to 20 and beyond. • Count 10-20 objects accurately. • Gives next number is sequence (1 - 10). • Count out 10 objects. • Identify numerals 1 -10. • Write some numerals and connects each to counted objects.	4-5 4-5 4-5 4-5	20a BP 20a BP 20a BP 20c BP 20c BP	• Instantly recognize and name the number of items in a set of four to five. • Make a small collection with the same number as another collection.	4-5	20b GB	• Use comparative language (*more, less, same)* to compare collections up to 10 by counting, even when the collection with the larger quantity of objects is made up of smaller objects. • Order three objects by one characteristic.	4-5 4-5	22 GB
5 and Kindergarten	• Count to 100 by ones and tens. * • Count forward from a given number.* • Write and represent numbers to 20.* • Count to tell "How many?" to 20. * • Count out objects to 20. *	5 – K 5-K 5-K	20a P 20a P 20c P 20a P	• Recognize and name the number of items in a set, up to five. • Conceptually subitize to 10.	5 - K	20b GB	• Show comparing situation with objects or in a drawing and match or count to find out which is more and which is less for two numbers less than or equal to 10. NRC		
Grade 1	• Count to 120 starting from any number. *	1st G 1st G		•					

How do progressions help us work with students?

There are general progressions of learning at early stages in numeracy.

Some children do not come to kindergarten with the skills needed to be successful.

The teacher needs to know where student is so she can take him/her further.

If student is unable to do a task, can go back and find where he needs to build knowledge in order to progress.

Early Numeracy Concepts

UNDERSTANDING COUNTING AND CARDINALITY

Asking “How many?”

Before cardinality is achieved-

- If children know fewer numbers than the number of objects they are to count, they will repeat numbers until the end.
- If children know more numbers than the number of objects they are to count, they will keep counting until they have said all the numbers they know.

Count sets of objects that begin small and increase as child becomes more adept.

Counting – What must a child know?

It is complex!

Each object to be counted must be touched or ‘included’ exactly once as the numbers are said.

The numbers must be said once and always in the conventional order.

The objects can be touched in any order, and the starting point and order in which the objects are counted does not affect how many there are.

Thee arrangement of the objects does not affect how many there are.

The last number said tells ‘how many’ in the whole collection. It does not describe the last object touched.

First Steps in Mathematics: Number, Western Australian Minister for Education

Counting

What could next steps be for this child?

Language affects math understanding

How do the English words we use to identify numbers reinforce or undermine mathematical concepts?

Think about these sequences:

1-10

11-13, 15

14, 16-19

20-29

30-39

Where could you include counting activities with children?

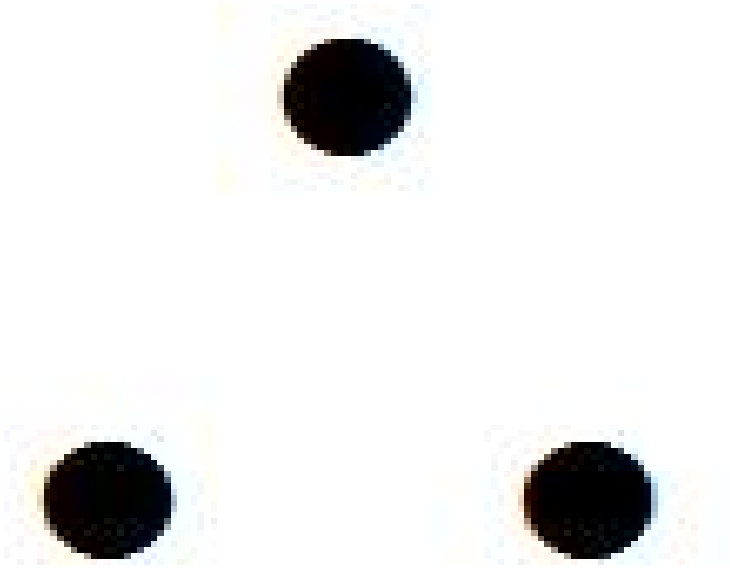
Discuss with an elbow partner how you might help your child(ren) learn to count objects.

Counting on

What does it mean to ‘count on’?

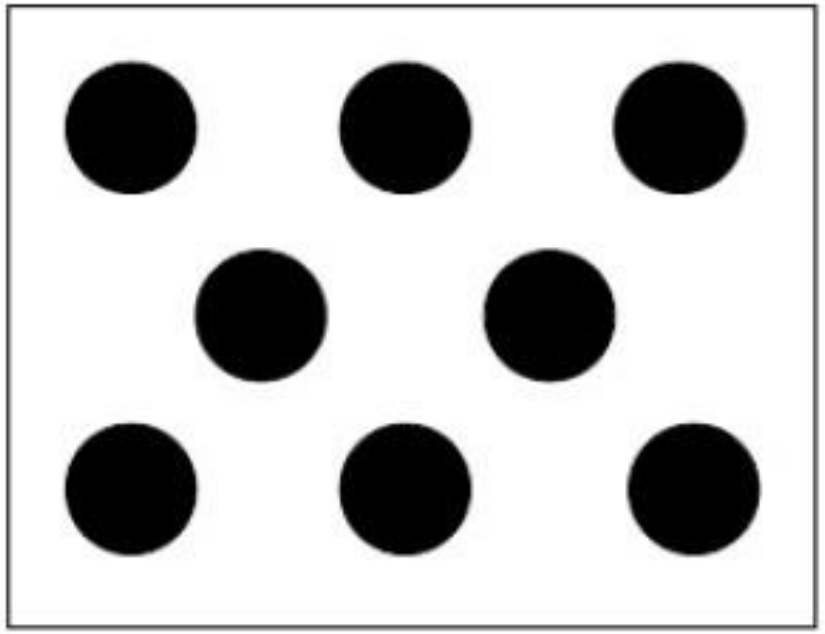
What additional skill is required if a child is to count on?

How many do you see?



How many do you see?

How did you visualize the dots?



Subitizing – What is it? Why teach it?

Children can visualize quantity without counting

Subitizing helps children understand part-whole relationships

Understanding part-whole relationships supports addition and subtraction operations

Persistent practice with subitizing activities will make it easier to count and manipulate numbers

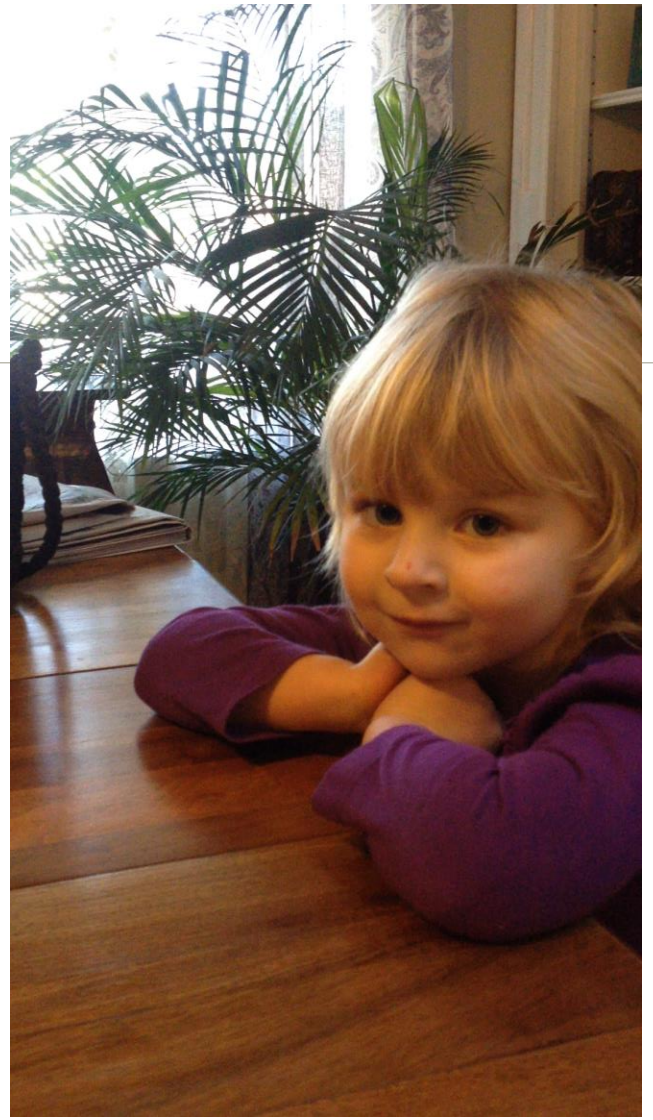
How the Brain Learns Math - Sousa

What do you observe?

Where is this child on the *Pathways* document?

What does this child not understand?

What might you have her do next?



Subitizing effects

What does this child know? How might you work with a child with these skills?

Subitizing and operations

Making sets

Where is this child on the pathways document?

What skills does he have?

What do you observe?

Look on the pathways document. What do you see that this child is able to do? What would help this child grow?

Comparing and Ordering

Children can tell the difference between small numbers of objects

If many objects, then large differences in numbers are easier to see.

Your thoughts?

What can you do today and tomorrow to engage children to become mathematicians?

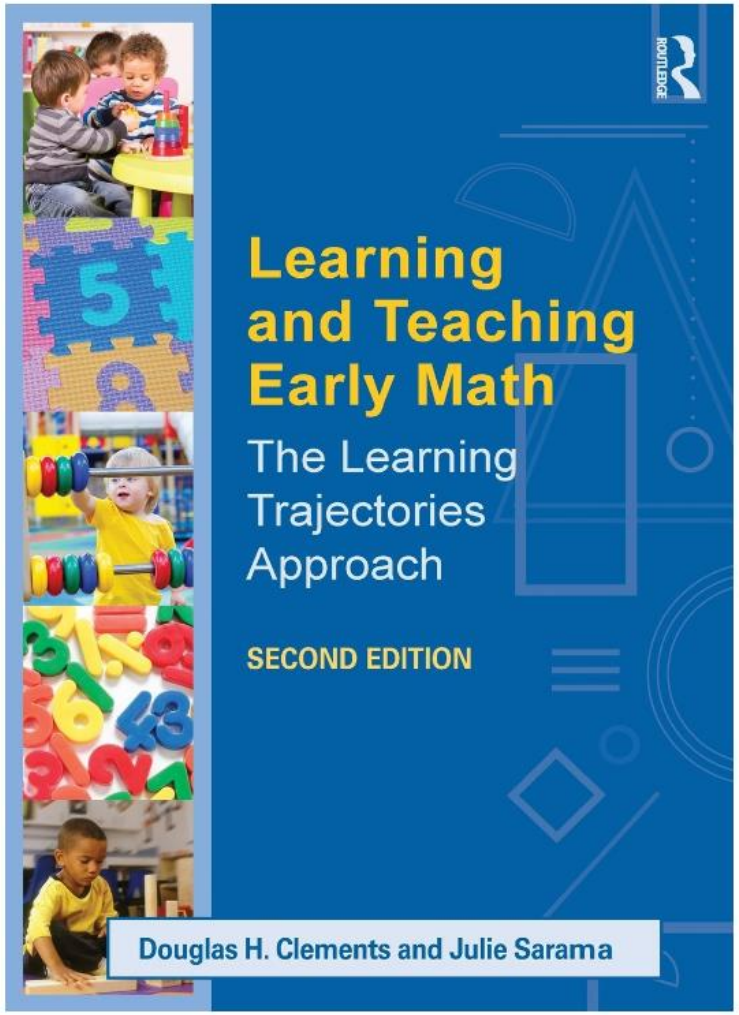
Share with an elbow partner.

What learning would you like to share with the group?

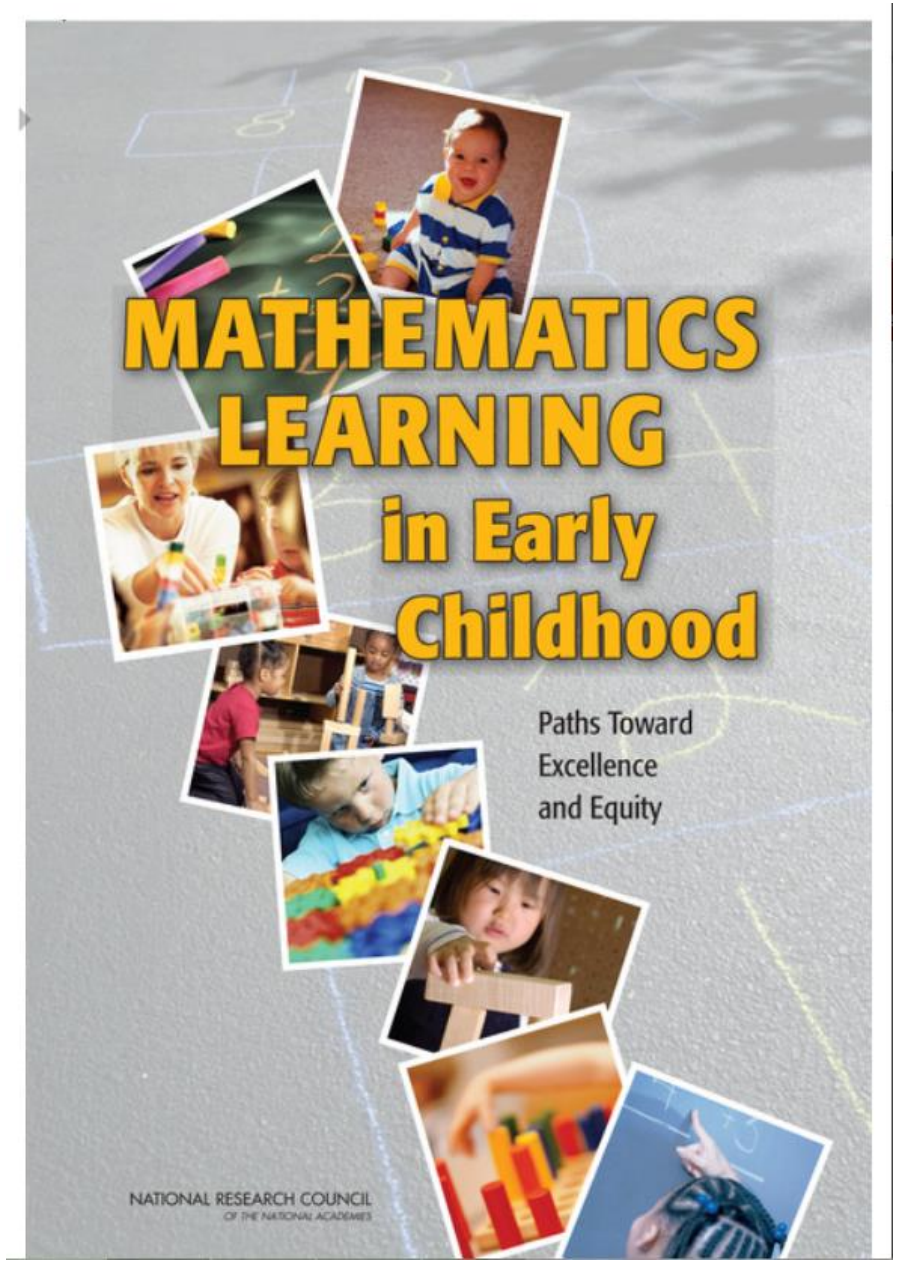
Resources

BECOMING AN ADVOCATE

Learning and Teaching Early Math: The Learning Trajectories Approach



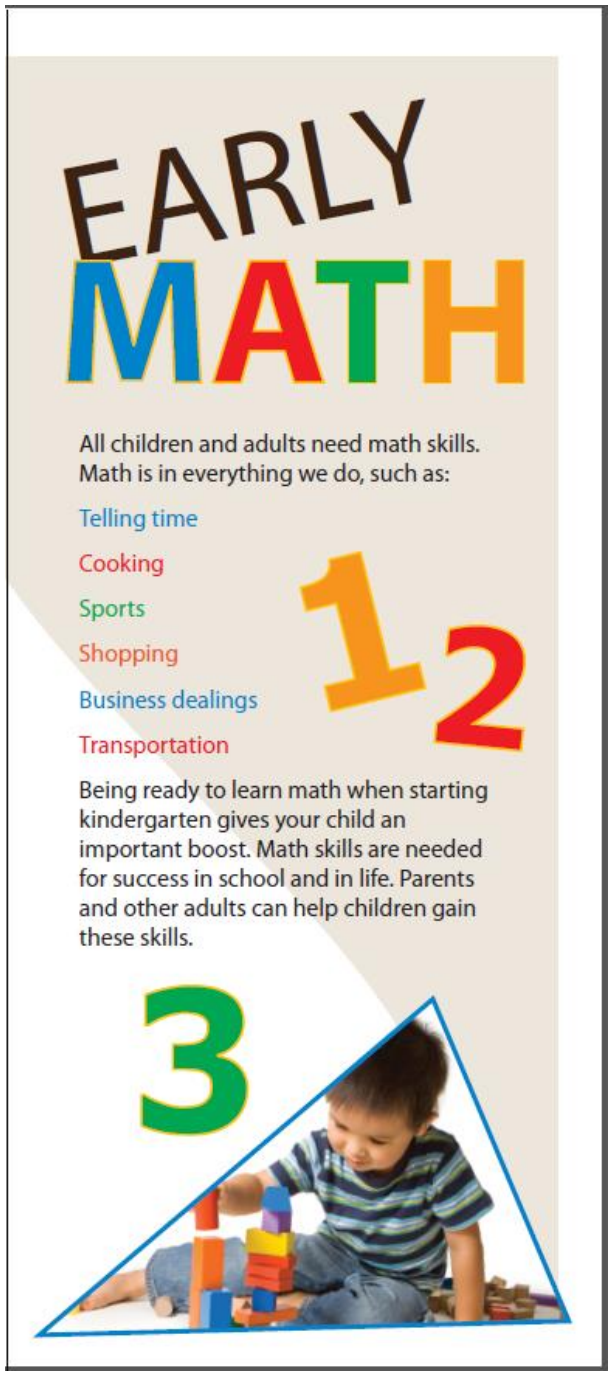
National Research Council



Early Math Brochure

Found online at:

http://www.k12.wa.us/EarlyLearning/pubdocs/earlycounting4.pdf



Illustrative Mathematics

- Activities for each standard
- Videos for some topics
- Professional development ideas

Illustrative Mathematics

Username or email
Password (forgot?) login
Sign up!

Explore the Standards
K-8 Standards
High School Standards
Standards for Mathematical Practice

Find Tasks
By Grade
By High School Category
Search All

Professional Development
Overview
Plan Your Program
Facilitated PD Workshops
Continue the Conversation

Other Resources
Fractions Progression Videos

Content Standards: Kindergarten Through Grade Eight

Need help finding tasks?

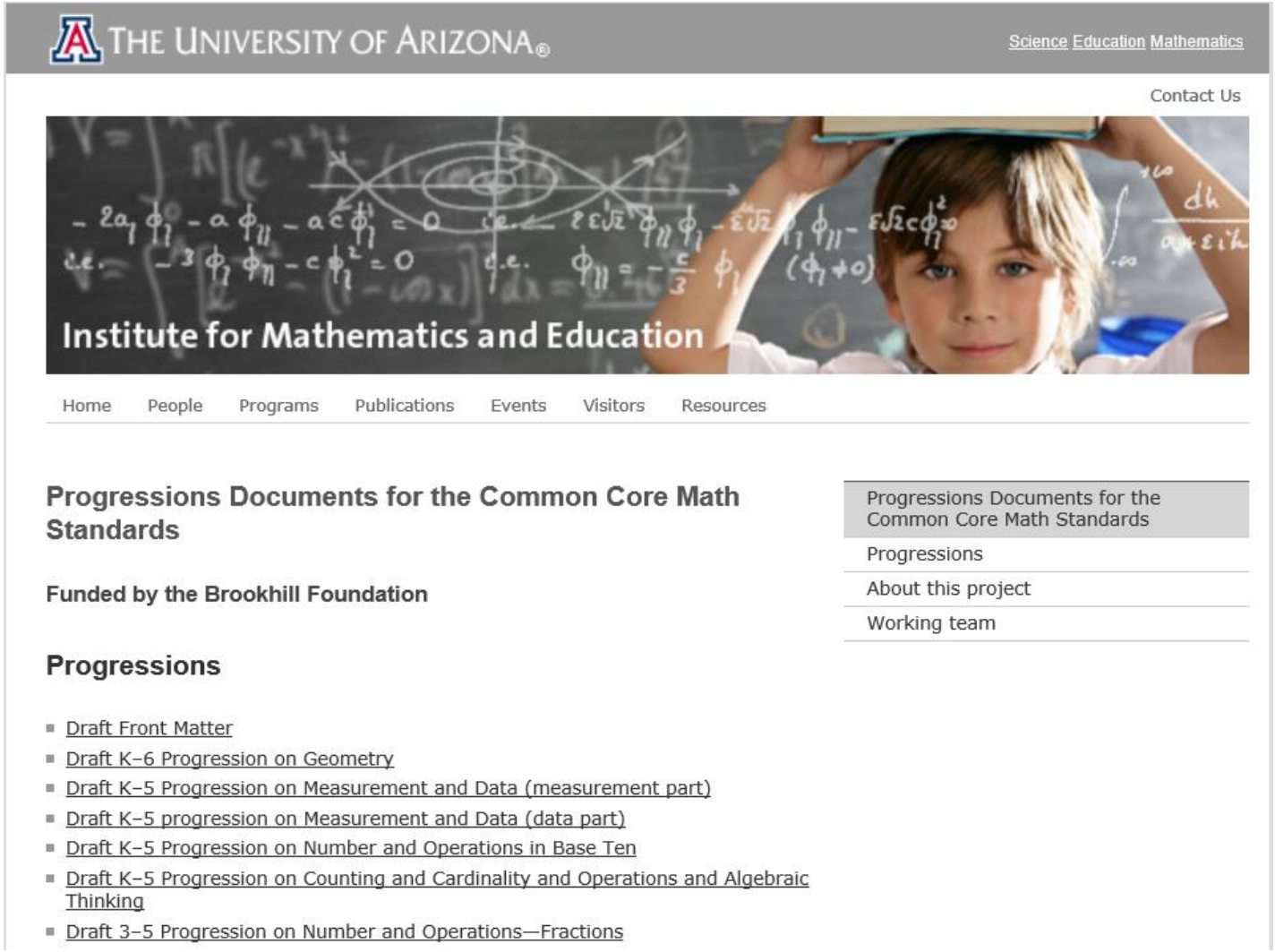
K	1	2	3	4	5	6	7	8
Geometry								
Measurement and Data						Statistics and Probability		
Number and Operations in Base Ten						The Number System		
Operations and Algebraic Thinking						Expressions and Equations		
Counting and Cardinality			Number and Operations---Fractions			Ratios and Proportional Relationships		Functions

Reveal standards automatically (?)

Progression Documents

progressions/

Progressions on each domain. Describes how the standards build upon each other.



Thank you!

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