



A Good Place to Start: Principles and Standards for High Quality Mathematics Education for 3- to 6- Year-Olds.

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Mathematics education must not be left to chance for the 3- to 6- year-olds in your program. Their future success in getting jobs and being able to understand the information they see on computers, TV and printed in magazines and newspapers depends on their ability to understand and feel comfortable with mathematics.

The National Council of Teachers of Mathematics (NCTM) along with the National Association for the Education of Young Children (NAEYC) have been the leaders in identifying and developing what mathematics education should be for 3- to 6-year-olds in any group setting, including day care centers, family and group family child care, preschool or public schools (http://www.naeyc.org/resources/position_statements/psmath.htm). They collaborated on a position statement *Early Childhood Mathematics: Promoting Good Beginnings* (2002) that explained what a high quality mathematics education is for 3-to 6-year-old children. This position statement includes a set of principles and standards that provide a framework for including high quality mathematics education in your program.

Principles of Mathematics Education in Early Childhood Programs

Principles are a set of beliefs that shape our behavior and influence our choices. There are six mathematical principles identified in the NCTM and NAEYC's position statement that explains what ideas must support mathematics education. They are discussed below. Each principle provides information about how to develop each child's "deep understanding" of mathematics so they will be successful in school and as adults.

Equity

Excellence in mathematics education requires equally high expectations and strong support for all children (http://www.naeyc.org/resources/position_statements/psmath.htm).

Make sure that the children in your care have plenty of opportunities to do mathematics. Model and communicate high expectations for learning mathematics. Make sure you don't communicate to children that math is hard and can only be mastered by a few. Absolutely everyone must know and feel comfortable with mathematics. Get to know mathematics so that you can identify children in your care who may have a learning disability, such as dyscalculia or who have exceptional talent.

Curriculum

A curriculum is more than a collection of activities; it must be coherent, focused on important mathematics, and well articulated across the grades (http://www.naeyc.org/resources/position_statements/psmath.htm).

In order to support each child's meaningful learning about mathematics, find out where each child in your care is developmentally. Be knowledgeable and comfortable with math. You will need to know about specific math content and processes. Provide well-planned activities, materials, experiences. Activities that reflect a commitment to high quality mathematics education shouldn't be random or spur-of-the-moment. They need to be offered regularly and for a specific purpose. According to the drafters of the



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NCTM and NAEYC position statement, *Early Childhood Mathematics: Promoting Good Beginnings* (2002),

[Providers] should ensure that the mathematics experiences woven throughout the curriculum follow logical sequences, allow depth and focus, and help children move forward in knowledge and skills. The curriculum should not become...a grab bag of any mathematics-related experiences that seem to relate to a theme or project. Rather concepts should be developed in a coherent, planful manner. (http://www.naeyc.org/resources/postion_statements/psmath.htm).

Teaching

Effective mathematics teaching requires understanding of what children know and need to learn and then challenging and supporting them to learn it well

(http://www.naeyc.org/resources/postion_statements/psmath.htm).

Children learn mathematics through the activities and materials that you provide. These experiences should be planned and carried out in a way that reflects your knowledge of how children grow and develop physically, social-emotionally, and cognitively. These experiences should also reflect each child's specific interests, culture and background of experience. You will also need to decide what math content and process to cover as well as create an environment where serious mathematical thinking takes place. Teaching also includes identifying the kind of scaffolding (questions you will ask and specific physical or material help you will provide to support each child's learning without taking over the process. Children will also need your ability to recognize their Zone of Proximal Development in order to become foster their learning in mathematics.

Teaching mathematics effectively also includes keeping up with your own professional development. It's important that you regularly include mathematics as training topic to cover to meet your licensing and registration requirements. Maintaining a deep understanding of mathematics is important to the intellectual development and educational well-being of the children in your care. .

Learning

Children must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge (http://www.naeyc.org/resources/postion_statements/psmath.htm).

This principle reflects the idea that knowledge is constructed. It also suggests that play is the best and most appropriate way to teach children mathematics. According to the drafters of the NCTM and NAEYC position statement, *Early Childhood Mathematics: Promoting Good Beginnings*, (2002),

Children become intensely engaged in play. Pursuing their own purposes, they tend to tackle problems that are challenging enough to be engrossing yet not totally beyond their capacities. Sticking with a problem – puzzling over it and approaching it in various ways—can lead to powerful learning. In addition when several children grapple with the same problem, they often come up with different approaches, discuss and learn from one another. These aspects of play tend to prompt and promote thinking and learning in mathematics and in other areas. (http://naeyc.org/resources/postion_statements/psmath.htm.)



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Assessment

Assessment should support the learning of important mathematics and furnish useful information to both teachers and students (http://www.naeyc.org/resources/position_statements/psmath.htm).

Assessment should be a part of any learning experience you provide. You use the information you get from assessments to make decisions about what to do next. It's important to regularly assess each child's mathematical understanding and skill. Assessments should be authentic. Results from your assessments can tell you that you may need to provide different materials or experiences or present mathematical ideas in a different way so that all children can learn the concepts and skills you are teaching. The assessments should ask children to use the knowledge and skills that they have learned in ways that are real and meaningful to them. Assessments should be done in many different ways, because children learn in many different ways. Include information from your observations, questions, interviews, developmental checklists and writing tasks in your assessments.

(<http://teach.scholastic.com/professional/assessment/perfassess.htm>).

Technology

Technology is essential to teaching and learning mathematics; it influences the mathematics that is taught and enhances children's learning (http://www.naeyc.org/resources/position_statements/psmath.htm).

Calculators, computers, GameboySPs, Play Stations, DVD players, cell phones, palm pilots, CD-ROMs, and Direct TV are examples of some of the technologies that are available today. The math that you do with children should reflect this. The wise and appropriate use of technology can help children learn math more deeply. Technology can also make mathematics more accessible to children with special needs.

Standards of Mathematics Education in Early Childhood Programs

Standards are the goals we want children to reach in a specific area. The National Council of Teachers of Mathematics (NCTM) identified 10 standards. Five of the standards explain the content that should be covered and the second five describe the processes that should be used.

Content Standards

Number and operations (e.g. adding subtracting, multiplying and dividing) geometry, measurement, algebra/pattern, displaying and analyzing data and probability (i.e. the chance something will happen) are content standards in mathematics education. In their joint position statement on what mathematics education should be for 3- to 6- year-olds, The National Council of Teachers of Mathematics (NCTM) and the National Association of Early Childhood Education (NAEYC) stated that focusing on number and operations, geometry, and measurement is especially important. These three content areas provide depth to the curriculum.

Since helping young children develop a deep understanding of mathematics is the goal when teaching mathematics, it's important to remember that random and isolated activities are not enough. Programs that effectively teach mathematics "plan[s] for children's in-depth involvement with mathematical ideas, including helping families extend and develop these ideas..."

(http://www.naeyc.org/resources/position_statements/psmath.htm).



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Content in math should be covered systematically. Learning paths or sequences show how concepts and skills in each of the content areas build on each other

(http://www.naeyc.org/resources/position_statements/psmath.htm). Below are examples of learning paths and teaching strategies for each of the five content areas. They have been adapted from information provided by the National Council of Teachers of Mathematics and the National Association for the Education of Young Children.



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Number and Operations

Number and operations are more than counting. Number and operations includes *number sense*. Some researchers believe that number sense is to learning about mathematics as phonological awareness is to learning how to read. Children have to make the connection between letter sounds and letter names – phonological awareness in order to be able to read. Children who don't have number sense have difficulty thinking about and working with numbers easily and understanding their uses and relationships. (http://www.ldonline.org/ld_indepth/math_skills/gersten_dyscalculia.html). This lack of number sense in mathematics is called dyscalculia.

Children with number sense can count accurately and competently, can continue counting on from a specific number as well as count backwards. Children with number sense can see relationships between numbers, and to be able to take a specific number apart and put it back together again (<http://www.ed.gov/pubs/EarlyMath/whatis.html>).

Number and Operations	From Age 3	Age 6	Teaching Strategies
<ul style="list-style-type: none"> Understand numbers, ways of representing numbers, relationships among numbers, and number systems. Understand meanings of operations (addition, subtraction, etc.) and how they relate to one another. Compute fluently and make reasonable estimates. 	Counts a collection of 1-4 items and begins to understand that the last counting word tells "how many".	Counts and produces (counts out) collections up to 100 using groups of 10.	Models counting of small collections and guides children's counting in every-day situations, emphasizing that we use one counting word for each object. Models counting by 10s while making groups of 10s.
	Quickly "sees" and labels collections of 1-3 with a number.	Quickly "sees" and labels with the correct number "patterned" collections (dominos) and unpatterned collections of up to about 6 items.	Gives children a brief glimpse of a small collection of items and asks how many there are.
	Adds and subtracts nonverbally when numbers are very low. For example, when one ball and then another are put into the box, expects the box to contain two balls.	Adds or subtracts using counting-based strategies such as counting on (adding 3 to 5, child says "five six, seven, eight") when numbers and totals do not go beyond 10.	Tells real-life stories involving numbers and a problem. Asks "how many" questions (How many are left? How many are there now? How many did they start with? How many were added?).



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Geometry

Geometry is all about shapes, sizes, space, position, direction and movement. Geometry helps children to describe and classify their physical world. Spatial sense is also a part of geometry. Spatial sense is all about children developing an awareness of themselves in relationship to others and objects. Providing many different types of blocks and planning well thought out block experiences support children's development in this area (<http://www.ed.gov/pubs/EarlyMath/whatis.html>).

Geometry	From Age 3	Age 6	Teaching Strategies
<ul style="list-style-type: none"> Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships. Specify locations and describe spatial relationships using coordinate geometry and other representational systems. Apply transformations and use symmetry to analyze mathematical situations. Use visualization, spatial reasoning, and geometric modeling to solve problems. 	<p>Begins to match and name 2-dimensional and 3-dimensional shapes, first only with same size and orientation, then shapes that difference in size and orientation (e.g., a large triangle sitting on its point with a small one sitting on its side).</p>	<p>Recognizes and names a variety of 2-dimensional and 3-dimensional shapes (quadrilaterals, trapezoids, rhombi, hexagons, spheres, cubes) in any orientation.</p> <p>Describe basic features of shapes (number of sides or angles).</p>	<p>Introduces and labels a wide variety of shapes (skinny triangles, fat rectangles, prisms) that are in a variety of positions (a square or a triangle standing on a corner, a cylinder "standing up" or horizontal).</p> <p>Involves children in constructing shapes and talking about their features.</p>
	<p>Uses shapes, separately, to create a picture.</p> <p>Describes object locations with spatial words such as under and behind, and builds simple but meaningful "maps" with toys such as houses, cars, and trees.</p>	<p>Makes a picture by combining shapes.</p> <p>Builds, draws, or follows simple maps of familiar places, such as the classroom or playground.</p>	<p>Encourages children to make pictures or models of familiar objects using shape blocks, paper shapes, or other materials.</p> <p>Encourages children to make and talk about models with blocks and toys</p> <p>Challenges children to map a path from a table to the wastebasket with masking tape, then draw a map of the path, adding pictures of objects appearing along the path, such as a table or easel.</p>



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Measurement

Measurement is finding out the length, height, and weight of objects using familiar measuring units like inches, feet, and pounds. But measurement can also be discovering the physical dimensions of objects using units of measurement that are more well known to children. For example, how many blocks tall is your tower or how many cereal boxes long is your road? We measure time using hours, seconds, and minutes. 3- to 6-year-olds will not have this concept of time. But they can understand “Who can jump up and down the longest?” Or “You have five more minutes to play before it’s time to clean-up.” and “it will be story and nap time after lunch.” Measurement is an important way for young children to look for and see relationships in the real world (<http://www.ed.gov/pubs/EarlyMath/whatis.html>).

Measurement	From Age 3	Age 6	Teaching Strategies
<ul style="list-style-type: none">• Understand measurable attributes of objects and the units, systems, and processes of measurement.• Apply appropriate techniques, tools, and formulas to determine measurements.	<p>Recognizes and labels measurable attributes of objects (I need a long string: Is this heavy?).</p> <p>Begins to compare and sort according to these attributes (more/less, heavy/light; This block is too short to be the bridge.).</p>	<p>Tries out various processes and units for measurements and begins to notice different results for one method or another (for example, what happens when we don’t use a standard unit.).</p>	<p>Uses comparing words to model and discuss measuring (This book feels heavier than that block. I wonder if this block tower is taller than the desk.).</p> <p>Uses and creates situations that draw children’s attention to the problem of measuring something with two different units (making garden rows “four shoes” apart, first using an adults shoe then a child’s shoe.).</p>



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Algebra/Patterns

Patterns and relationships are part of algebra. Patterns are things that repeat; relationships are connections made between things based on some reason. Patterns and relationships are important because they show us that there is an organization. Patterns and relationships help us to know what comes next, even if we can't see it yet (<http://www.ed.gov/pubs/EarlyMath/whatis.html>).

Algebra/Patterns	From Age 3	Age 6	Teaching Strategies
<ul style="list-style-type: none">• Understand patterns, relations, and functions.• Represent and analyze mathematical situations and structures using algebraic symbols.• Use mathematical models to represent and understand quantitative relationships.• Analyze change in various contexts.	Notices and copies simple repeating patterns, such as a wall of blocks with long, short, long, short, long, short, long.	Notices and discusses patterns in arithmetic (adding 1 to any number results in the next "counting number.").	Encourages, models, and discuss patterns (What's missing? Why do you think that is a pattern? I need a blue next). Engages children in finding color and shape patterns in the environment, number patterns on calendars and charts (with the numbers 1-100), patterns in arithmetic (recognizing that when zero is added to a number, the sum is always that number.).



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Displaying and Analyzing Data and Probability

We organize and interpret information and see relationships using charts and graphs. Using pictures such as charts and graphs is a way to show and see information mathematically. Charts, including calendars, are ways to organize information. Probability tells us about the likeliness of something happening. Examples of this include talking with children about the weather and the relationship between gray clouds and the possibility of rain (<http://www.ed.gov/pubs/EarlyMath/whatis.html>).

Displaying and Analyzing Data and Probability	From Age 3	Age 6	Teaching Strategies
<ul style="list-style-type: none"> Formulate questions that can be addressed with data, and collect, organize, and display relevant data to answer them. Select and use appropriate statistical methods to analyze data. Develop and evaluate inferences and predictions that are based on data. 	<p>Sorts objects and counts and compares the groups formed.</p> <p>Helps to make simple graphs (pictograph formed as each child places her own photo in the row indicating her preferred treat- pretzels or crackers.</p>	<p>Organizes and displays data through simple numerical representations such as bar graphs and counts the number in each group.</p>	<p>Invites children to sort and organize collected materials by color, size, shape, etc. Asks them to compare groups to find which group has the most.</p> <p>Uses “not” language to help children analyze their data (All of these things are red and these things are NOT red).</p> <p>Works with children to make simple numerical summaries such as tables and bar graphs, comparing parts of the data.</p>

Process Standards

Problem solving, reasoning, communication, connections and representation are the processes children need to know to become fluent in mathematics. They need to know these processes so they can learn what to do with the math content they learn content.

Problem Solving

Problem solving is the ability to explore, think through an issue and reason logically to solve all kinds of problems. Problem solving is the key to being able to understand all mathematics. When children use problem solving they learn that there are lots of different ways to solve problems and there is often more than one right answer.

Communication

We usually think about communication as talking with children and listening to them. This kind of communication is important in the development of mathematical thinking. But communication also means learning ways to express ideas with words, diagrams, pictures, and symbols. Children need opportunities to talk about what they are doing. Talking helps them think more clearly. Talking also



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helps a child's concrete experiences become mental operations. This change is a critical transformation in a child's cognitive development.

Reasoning & Proof

Reasoning is the process we use to think through a question, a problem, or a situation and come up with a useful or logical answer. Proof is the evidence used to support our answer or solution. Children need to be invited to share their thinking about how they arrived at an answer – the process and the proof. In this case children not only need to answer why and how questions, they also need to supply the “because.” Reasoning and proof are also a big part of problem solving.

Connections

Connections are about relationships. There are lots of relationships to discover in mathematics. Mathematics is more than the isolated skills and procedures of counting, adding, subtracting, multiplying and dividing. We can find mathematics in science, art and music. We find it clothing Children need to see that mathematics is all around them and make connections with it.

Representation

Representation is all about taking something that is concrete and having it stand for a symbol or a mental idea. When children learn about numbers they need to count things, fingers, balls, peas on their plates. Representation is also about using pictures, graphs, and diagrams to show mathematical ideas. For example a graph made out of pictures of different types of apples (red delicious, golden delicious and granny smiths to show how many children in the class like each of these different types of apples. Representation is very important in a child's cognitive development. Before the number 3 or the concept of biggest to smallest can be understood and used mentally, children need to have experience these concepts concretely. That's why it's so important we give children objects to count, graduated cylinders to put in size order.

In Conclusion

In order to make sure that the 3- to 6-year olds in your care are well prepared to deal with the math that is all around them, it's vital that you provide high quality mathematics education. High quality mathematics takes knowing what, why, when and how. You will need to know:

- what to teach,
- why to teach it,
- when to teach it and
- how you are teaching it.

A positive attitude toward mathematics and fluency in mathematics begin in early childhood. This good beginning should reflect your thorough understanding of children's development and learning; knowledge of appropriate early childhood curriculum and teaching practices and on-going assessment of children's learning. The children are depending on it.



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