

Essential Instructional Practices In Early Mathematics PK-2



Introduction- NCTM Position

Research on children's learning in the first eight years of life demonstrates the importance of early experiences in mathematics. An engaging and encouraging climate for children's early encounters with mathematics develops their confidence in their ability to understand and use mathematics. These positive experiences help children to develop dispositions such as curiosity, imagination, flexibility, inventiveness, and persistence, which contribute to their future success in and out of school (Clements & Conference Working Group, 2004).

Early childhood educators should actively introduce mathematical concepts, methods, and language through a variety of appropriate experiences and research-based teaching strategies. Teachers should guide children in seeing connections of ideas within mathematics as well as with other subjects, developing their mathematical knowledge throughout the day and across the curriculum. They must encourage children to communicate, explaining their thinking as they interact with important mathematics in deep and sustained ways.

[NCTM's eight Mathematics Teaching Practices](#) represent a set of high-leverage practices and essential skills necessary to promote deep learning of mathematics. This document highlights applications of these practices to mathematics instruction in the PreK- Grade 2 classroom.

NCTM's Mathematics Teaching Practices

- Establish mathematics goals to focus learning.
- Implement tasks that promote reasoning and problem solving.
- Use and connect mathematical representations
- Facilitate meaningful mathematical discourse.
- Pose purposeful questions.
- Build procedural fluency from conceptual understanding.
- Support productive struggle in learning mathematics.
- Elicit and use evidence of student thinking

PtA Teaching Principle 1-*Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.**

Considerations for the Early Childhood Classroom

Learning Goals provide for the intentional and effective teaching of mathematics in the early years. The mathematics concepts learned in PK and K are the core of students' mathematical career—all future mathematics is based on this learning. In the early years, the developmental progressions, which are based on children's natural development of math skills, enable early childhood educators to meet children 'where they are' and move them forward mathematically. Learning goals in PK and K inform the development of the standards that are part of the PK-5 sequence.

Early Childhood Teachers:

- Plan learning goals based on the knowledge and understanding of young children's cognitive, linguistic, physical, and social-emotional development.
- Plan learning goals based on the MD College and Career-Ready Standards
- Plan learning goals using the [learning trajectories](#) . Learning trajectories have three parts: a mathematical goal, a developmental path through which children develop to reach that goal, and a set of activities matched to each of those levels that help children develop the next level. Thus, each learning trajectory has levels of understanding, each more sophisticated than the last, with tasks that promote growth from one level to the next.
- Understand that the learning trajectory (progressions) are not linear pathways. Learning mathematics is multi-dimensional. Children may be learning to count and are also able to sort objects or work with shapes. Teachers are able to connect mathematics concepts within grade-level domains
- Plan learning goals based on where each child falls on the learning trajectory for a particular math concept. The learning goal should build on students' prior knowledge and help children to develop to the next level of learning. Instruction should be targeted just beyond children's current understanding (Vygotsky, 1978)

PtA Teaching Practice 2: Implement Tasks that Promote Reasoning and Problem Solving

*Effective teaching of Mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solutions strategies.**

Considerations for the Early Childhood Classroom

Early Childhood educators understand that young children are naturally curious and are natural problem solvers. They construct their own understanding and are curious about new tasks. Young children bring a wealth of mathematical knowledge to school. They are strongly motivated to do mathematics and tend to be more task-learning-motivated (motivated by learning and view a task as something to be successful) rather than performance-oriented (motivated by other's approval and often 'perform' for others approval, more focused on the right answer). Teachers should build on this natural curiosity and motivation to help students make sense of the mathematics and build their understanding of mathematical ideas. Remember that play is the work of childhood. It is the practice of learning through experiments and exploring new ideas. Play is not random, but it is an intentional approach to allow children to construct meaning from the activities which promote problem solving and reasoning. Provide opportunities for intentional play to allow students to construct meaning from the activities in which they are engaged. Playful learning takes many forms and looks as students grow older.

Early Childhood Teachers:

- Select tasks or problems that:
 - Promote reasoning and problem solving.
 - Build on students' prior knowledge and experiences.
 - Access the mathematics idea through various entry points.
 - Allow students to make sense of the mathematics- Be the doers of math.
 - Use a variety of different representations and tools.
 - Provide for a variety of solution suggestions
 - Incorporate play as the vehicle through which children learn
- Create a classroom environment that encourages problem solving, reasoning and sense making. Provide uninterrupted time for students to engage with and explore a variety of materials, situations, and opportunities that involve mathematical ideas. Provide significant intentional time for students to develop, construct, test, and reflect on their mathematical understanding.
- Mathematize the classroom. Use a 'math lens' to provide multiple opportunities for children to be engaged with the mathematics content and practices that are built into the fabric of the classroom.

Essential Mathematics Teaching Practices in the Early Childhood Classroom

- Select activities/tasks that match the developmental level of students within the learning progressions that will help them grow to the next level. Provide opportunities for purposeful play that allows students to explore and experiment with numbers.
- Allow students to solve problems and answer questions encountered during everyday class routines. (Rather than the adult doing it for the students.) For example: Have children determine the lunch count or the attendance; decide how many days are there until.... , answer questions such as-“Do you have enough blocks to”, “How many... do you need?”.
- Strategically plan math workstation/center activities that make use of previously taught math concepts or skills. Provide time for students to explore materials (e.g., blocks) in a self-directed and play-based environment. As concepts and skills are taught, provide opportunities to apply them in a more structured workstation/center that intentional reinforces the new learning.
- Use literature books to introduce a mathematical concept, create a context for solving a problem, and build mathematics vocabulary. Discuss a character’s action to decide if it makes sense or to reason why a character did something.
- Model problem solving strategies and dispositions
- Recognize the power of play and how it is the practice of learning through experiments, exploring new ideas, and problem solving. Consider the different forms of play when planning mathematics tasks.
- Utilize centers in PK-Grade 2 as a way to engage students in problem solving and reasoning, provide differentiation and choice, engage students in constructing their own learning and make meaning of the mathematics. Center activities also promote the use of mathematics vocabulary, listening to others’ reasoning and learn different strategies and concepts.
- Interact with students during play and during planned mathematics instruction. Ask questions that foster reasoning. For Example: How do you know?, Why do you think? What would happen if...?, I wonder how this could be changed?, What else can you find that...? Encourage the use of mathematics vocabulary
- Model reasoning language during the class day. Think aloud as you reason or express your thinking about a problem.

PtA Teaching Practice 3: Use and Connect Mathematical Representations

Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures as well as tools for problem solving.*

Considerations for the Early Childhood Classroom

Young children, by nature, are constructivist learners. They make sense of the mathematics, which by nature is abstract, through exploration, discovery, hands-on tasks, and problem solving. Representations make mathematical concepts and relationships understandable. The Early Childhood classroom typically uses concrete objects, drawings, symbols, and movement to help children make sense and to understand the mathematics. The use of [the Levels of Abstraction](#) provide a structure for using multiple representations of mathematical ideas. Recent brain research has found a strong connection between visual mathematics and understanding. Good mathematics teachers use visuals, manipulatives, and motion to enhance students' understanding for mathematics. ([Jo Boaler, *Seeing As Understanding: The Importance of Visual Mathematics for Our Brain and Learning*, Stanford University](#))

Early Childhood Teachers:

- Introduce students to a wide variety of representations from the concrete objects, fingers, to the pictorial (drawings, maps) graphical (bar graphs, picture graphs, tables, etc,) and to the symbolic (numbers, symbols) to visualize mathematical ideas.
- Provide multiple opportunities for students to interact with the various visual representations to build conceptual understanding and allow students to make sense of the mathematical ideas through visual representations.
- Use movement, acting out, and work in a variety of centers for children to represent mathematical ideas and solve problems.
- Have students use concrete objects and drawings, fingers, etc. to explain and justify their reasoning. Display student work or post pictures taken (e.g taken with iPad or cell phone) of student work that support the levels of abstraction
- Use mathematics literature books or real life situations to establish a context for a task or problem. Use multiple representations to represent the context of the problem and the answer.
- Select mathematics activities and tasks that allow multiple representations to show conceptual understanding.

PtA Teaching Practice 4: Facilitate Meaningful Mathematical Discourse

*Effective teaching of mathematics facilitates discourse among students to build understanding of mathematical ideas by analyzing and comparing student approaches and arguments. **

Considerations for the Early Childhood Classroom

In the early childhood classroom, vocabulary development is a key element. Mathematical discourse includes an exchange of ideas through conversations and students sharing their thinking as well as through other forms of verbal, visual, and written communication.

Mathematical discourse is critical in the mathematics classroom to help students reason mathematically and to communicate their reasoning. Mathematical discourse provides the following additional benefits:

- Reveals understanding and misunderstanding.
- Supports robust learning by boosting memory.
- Supports language development.
- Contributes to the development of social skills.
- Allows students to hear the thinking of others
- Provides opportunities for students to share ideas and solutions
- Allows students to easily ask questions
- Informs instruction

Early Childhood Teachers:

- Use student questions and conversations while children are at play to encourage talking about mathematical ideas with other students. ('everyday language of math') Connect everyday language with mathematics vocabulary
- Provide a variety of materials and opportunities for children to communicate their mathematical ideas with each other. Students should manipulate objects, use fingers, make drawings, etc. to communicate their thinking and reasoning.
- Encourage children to explain their thinking and reasoning and how they completed a task or solved a problem. Encourage the use of mathematics vocabulary.
- Have students use literature, manipulatives and drawings as a basis for explaining their thinking or engaging in math conversations. Encourage the use of mathematics vocabulary.

Essential Mathematics Teaching Practices in the Early Childhood Classroom

- Engage students in purposeful sharing of ideas, reasoning, thinking using think-pair-share, small group and whole class discourse.
- Use Math Talk routines to provide opportunities for students to share reasoning, thinking, problem solving. (Think-pair-share, re-voicing, etc.) Encourage children to use mathematics vocabulary in their explanations
- Provide sentence starters for activities and games so students have a starting point for sharing. Include mathematics vocabulary in the sentence starters
- Listen carefully to what students are saying. Re-verbalize, ask questions to extend their thinking, or clear up misunderstandings.
- Provide time for students to explore materials (e.g., blocks) in a self-directed and play-based environment. As concepts and skills are taught, provide opportunities to apply them in a more structured workstation/center that intentional reinforces the new learning. During these experiences encourage math talk between students and teacher and students.

PtA Teaching Principle 5: Pose Purposeful Questions

*Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships**

Considerations for the Early Childhood Classroom

When planning, teachers should consider the types of questions to ask to elicit evidence of student thinking. A variety of questions should be planned for different purposes such as gathering evidence; probing students reasoning; helping students see connections between mathematical concepts or to encourage reflection. Teachers must also realize that some questions come as a response to something a student says and cannot be planned.

Early Childhood Teachers:

- Pose purposeful questions to better understand students' reasoning and how they are making sense of mathematical ideas. Use general open ended statements/ questions such as: Tell me about (what you built, made, created, found, etc.) How did you..., What would happen if...?, How can you...?, How are they alike, different?, How did that happen? Tell me what you saw..., Tell me how you worked together.,
- Have math conversations throughout the day with individual or small groups of children that will expand their thinking. Help them solve problems, reason, and apply their understanding to the next phase of development. Encourage students to engage in these conversations with other students as well.
- Encourage young learners to ask other students questions. Provide question prompts to help them phrase the questions.
- Allow sufficient wait time so that students can gather their thoughts before they respond.
- Encourage young children to use materials, drawings, and mathematics vocabulary to share their thinking or explanation.

PtA Teaching Practice 6- Build procedural fluency from conceptual understanding

*Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.**

Considerations for the Early Childhood Classroom

In early childhood mathematics, especially in PreK and K, students are building the foundational concepts that support the understanding of mathematical ideas. Conceptual understanding of the mathematics begins in the early grades. Developing a deep conceptual understanding of mathematical ideas such as subitizing, developing conservation of number, decomposing and composing numbers, and understanding the problem types of addition and subtraction, all build the understanding on which they will build an procedural fluency of concepts in later grades. Later in K and through grade 2, students begin to connect conceptual understanding to procedural knowledge using mental math strategies, properties of operations, understanding of place value.

Early Childhood Teachers:

- Build conceptual understanding with multiple experiences in multiple situations in a variety of ways over time (over months, years, not hours)
- Provide time for students to explore materials (e.g., blocks) in a self-directed and play-based environment. As concepts and skills are taught, provide opportunities to apply them in a more structured workstation/center that intentional reinforces the new learning
- Build conceptual understanding by connecting and integrating mathematical ideas through real life situations in their lives, school day, literature, other subjects.
- Build conceptual understanding using the levels of abstraction to introduce and use the different counting strategies to use to solve problems with procedural knowledge.
- PK/K/1 Build conceptual understanding of mental math strategies with concrete objects and later symbols and numbers. (counting on one /two doubles, doubles plus 1). Grades K-2 (make a 10, subtract from 10,)

PtA Teaching Practice 7: Support Productive Struggle in Learning Mathematics

*Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to productive struggle as they grapple with mathematical ideas and relationships.**

Considerations for the Early Childhood Classroom

In the early years, the implementation of constructivist pedagogy provides hands-on experiences, exploration and problem solving which naturally engages young learners in productive struggle, but in a developmentally appropriate way. Allowing students to engage in productive struggle helps them to understand they can learn value lessons from mistakes. In the early childhood classroom, students may be exposed to the idea of productive struggle when using a ‘trial and error’ method in the problem solving process. Through teacher facilitation, students learn to analyze results and make adjustments until finding a reasonable solution.

Early Childhood Teachers:

- Allow time for students to solve problems that naturally occur in the everyday experiences in the classroom.
Examples: When distributing supplies ask students to determine how many items, their group needs. Ask students if there are enough of a supply for their group.
- Avoid giving students the answers to problems. Giving answers removes the opportunity for students to solve problems in their own way.
- Focus on the process and thinking of the children, not getting a ‘right’ answer.
- Use questions to guide students who quickly give up a task to help them think of a different way to solve or complete the task.
- Encourage students try out solutions, consider the results, and recommend corrections or adjustments while they are solving a problem.
- Discuss why a strategy or plan may not have worked. Turn errors into learning opportunities.
- Use incorrect reasoning or solutions as opportunities to rethink a problem and learn from the error.

PtA Teaching Practice 8: Elicit and use evidence of student thinking

*Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning.**

Considerations for the Early Childhood Classroom

The first step for the early childhood educator is to develop an understanding of what counts as evidence of student thinking. Once clear on what counts as evidence of student thinking teachers must look for ways to elicit this evidence. When planning daily lessons the early childhood educator should consider what learning opportunities would allow them to gather evidence needed to assess where a student's learning is along a learning trajectory. Once gathered, the evidence must be analyzed to inform decisions as to how to respond to observed student needs.

Early Childhood Teachers:

- Use interactions with students during centers, small group, and large group settings to determine student's current level of mathematical understanding and reasoning.
- Use student work (concrete, pictorial, abstract) as evidence of their current level of understanding and to plan next steps for instruction.
- Use multiple types of formative assessment methods to understand where students are and to adjust instruction in ways to support and extend learning.
- Use introductory activities, observations, student interviews and performance tasks to determine each child's existing math knowledge or level of understanding he/she has reached on a developmental progression.
- Assess, record, and monitor each child's progress so that instructional goals and methods can be adjusted as needed.
- Observe students' play (in centers, small group, etc.) to learn more about children's understandings and stage of development in mathematics to plan next steps or adjust instruction.
- Use KRA baseline data to inform instructional planning