

## Early Math: It's More Than Numbers

by Ann S. Epstein

In the debate about whether preschoolers are too young for math or should be taught counting and basic arithmetic before school entry, the most defensible position is in the middle. Young children's natural curiosity about math arises in their everyday play and work. Our job is to provide them with appropriate words, materials, and experiences. To do this, we must recognize that math is more than numbers and rote counting. Children's investigations into size, quantity, categorization, patterns, space, speed, and sequence are all aspects of early math learning.

Young children vary widely in their thinking about math. The following incident, which took place at the High/Scope Demonstration Preschool in Ypsilanti, Michigan, is a good illustration:

*Nine children aged three to five were having snacks with their teacher. They passed around a bowl filled with a mixture of toasted O's, raisins, and pretzel sticks, serving themselves with a large spoon. Five-year-old Jessie placed two spoonfuls on her plate before giving the bowl to three-year-old Maya. "Take two spoons," Jessie advised, "so there's enough." Maya proceeded to fill her plate to overflowing and passed the still ample bowl to the next person. Jessie commented to the teacher, "Wow, you made a lot." "Yes," answered the teacher. I used one big box of toasted O's, two big bags of pretzels, and lots of raisins!"*

*Before eating his snack, four-year-old Eli divided it into separate piles of the three ingredients. Then he announced "I only like the pretzels and I didn't get too many." Five-year-old Ben was more interested in building with his snack than eating it. He inserted a pretzel stick into each toasted O, laying them out in a row. When he ran out of pretzels but still had a few toasted O's left, he said, "I need more pretzels to finish my fence." Borrowing Ben's idea, three-year-old Natalie inserted a pretzel in a toasted O and sang "Happy Birthday" to the teacher. When another child asked how old the teacher was, Natalie replied without hesitation, "Eleven."*

In this example, five-year-old Jessie thinks about quantity and the number of people, while three-year-old Maya just wants a lot for herself. Natalie shows she has a concept of numbers and may even understand that 11 is bigger, and therefore

older, than three or four. Eli and Ben both compare snack components and conclude they are short of pretzels, but get there by different problem-solving routes. Eli sorts the ingredients and sees that pretzels, his favorite, make up the smallest pile. Ben does one-to-one matching to discover his toasted O's outnumber his pretzels.

Three things are striking about this anecdote. First, we see that early math is tied to concrete objects. Second, children's actions and words present opportunities to extend their thinking. Third, math thinking happens without rote lessons. But learning does not happen on its own. Teachers need to systematically introduce mathematical experiences into the early childhood curriculum. With this goal in mind, this article describes how to promote math learning in five key areas: classification, seriation, number, space, and time. It offers instructional strategies to set up the learning environment, plan the daily routine, and interact with children. (For additional information on incorporating math into the curriculum, see Hohmann & Weikart, 2002 or visit our web site at [www.highscope.org](http://www.highscope.org).)



Dr. Ann S. Epstein is the director of the Early Childhood Division at the High/Scope Educational Research Foundation where she has worked since 1975. She develops early childhood curriculum materials, directs a team of early childhood specialists who conduct inservice training around the country and abroad, and supervises implementation of the High/Scope Demonstration Preschool, an NAEYC-accredited program. Dr. Epstein also conducts research and evaluation on a variety of federal, state, and local early childhood programs. She has developed observational instruments for monitoring program quality and assessing child development. Dr. Epstein has published numerous books and articles for professional and practitioner audiences on child development, staff training, and program evaluation. She has a Ph.D. in Developmental Psychology from the University of Michigan and also holds a Masters of Fine Arts degree from Eastern Michigan University.

## CLASSIFICATION

Classification — grouping things according to common traits — is one way children organize their lives. They develop rules for treating things the same or differently, based on their attributes.

**Learning environment:** Provide and label interesting materials, including:

- Household and natural materials with attractive characteristics (baby oil, sandpaper, shells)
- Materials with moving parts (kitchen utensils, musical instruments, cameras)
- Materials that change (clay, computer drawing programs, sand, water, real animals)
- Regularly shaped materials (blocks, boxes, rings, cards, pieces of wood, buttons, tambourines)
- Materials for sorting and matching (toy animals, bottle caps, beads, silverware, hats, shoes)
- Materials that encourage sorting according to two attributes, for example, plastic animals that come in two sizes and four colors.

**Daily routine:** Encourage children to collect and sort things throughout the day:

- Make time for collecting on the playground and on walks, as well as in the classroom.
- Use clean-up as a natural time for matching and sorting. Labeled storage areas also help children find and return materials independently.

**Adult-child interaction:** To encourage conventional and unconventional sorting:

- Ask children to make things that are the same, to make things that are different.
- Encourage children to use the symbol for the “no” concept (a line through the object or word).
- Challenge children with increasingly complex guessing games that require them to hold more than one mental image in mind.

## SERIATION

Classification groups objects by *similarities* while seriation orders them based on *differences* (e.g., smallest to largest) or a *repeating sequence or pattern* (e.g., alternating red and blue beads).

**Learning environment:** Provide materials whose attributes can be easily compared, including:

- Sets of materials in different sizes (nesting blocks, measuring spoons, paintbrushes, drums)
- Materials children can shape and change to create their own variations (beeswax, wet sand)
- Materials children can use to make their own series and patterns (beads, collage materials)
- Computer programs that allow children to recognize and create series and patterns
- Ordered sets of materials that go together (cards and envelopes, nuts and bolts)

**Daily routine:** To create opportunities for making comparisons, regularly do the following:

- Ask children to draw or make things that involve series and patterns, for example, sculpt a family, string a bead necklace, make a train with blocks, or create patterns with pegboards.
- Read and act out stories that feature graduated qualities, such as *The Three Bears* and *The Three Billy Goats Gruff*. Ask children to make beds for the three bears with play dough or choose instruments for the papa, mama, and baby based on variations in pitch or loudness.

**Adult-child interaction:** Listen for and extend the comparisons children make:

- *Repeat* children’s comments. At outside time, Abbey said “The worms in this bush are smarter than the ones in that bush. They know to hang higher up so they don’t get in my hair.” Her teacher agreed, “Yes, I suppose that does show these worms are smarter.”
- *Extend* children’s comments. Josh was washing his hands at one sink when his teacher Beth turned on the water in the next sink full blast. Josh said “Mine is running slow.” Beth turned down her water and said, “I made mine slower like yours.”

## NUMBER

Number involves equalities — like classification. It reflects ordered distinctions — like seriation — and one-to-one correspondence. Finally, number concepts develop with conservation, the idea that quantity remains fixed regardless of shape or spatial arrangement.

**Learning environment:** Provide materials that encourage comparing and counting.

# BEGINNINGS WORKSHOP

- Materials for comparing numbers — These include discrete materials such as beads, shells, and bottle caps that children can line up and count. Art materials also work well. Children enjoy comparing the number of colors in their paintings or the number of items in their collages.
- Materials with numbers on them — Examples include calculators, playing cards, wooden numbers to copy and trace, and simple board games with dice or spinners. (Remember rules are less important to young children than counting spaces as they move around the board!)
- Materials that fit together in one-to-one correspondence — Common materials are pegs and peg boards, colored markers and tops, egg cartons and plastic eggs. Children will use almost anything to create their own matched sets as they explore materials and act out role plays.

**Daily routine:** Howard Gardner says, “Preschoolers see the world as an arena for counting. Children want to count everything” (1991, p. 75). To support children’s natural love of counting:

- Encourage children to gather and distribute materials at snack, clean-up, and small-group time.
- Plan group activities that involve multiple numbers of the same items such as small toys and blocks, or materials collected by children on a nature walk, such as pebbles or shells.
- Make sign-up sheets that involve numbers. For example, on a sheet to take turns with a new camera, children made hatch marks after their names to indicate how many turns they wanted.

**Adult-child interaction:** We learn more from the questions children ask us than from the ones we ask them. Instead of drilling children, try the following:

- Listen to the kinds of things children commonly compare, such as materials (“My tower has more blocks than yours.”), things in representations (“I drew more teeth in my brother’s mouth because he talks louder.”), and ages (“My cousin is older than us. She’s seven.”).
- Comment on the sets of corresponding materials that children generate. (“Jason, I see you put one bear on each block. You have five bears on five blocks.”)
- Use written numbers and support children who are interested in writing numbers themselves.

## SPACE

Preschoolers negotiate the physical world with confidence. They run and climb, follow familiar routes, solve puzzles,

write in two dimensions, and build in three dimensions. To expand their awareness of space, enable children to move about the classroom freely. Better organization can create more space without significantly reducing the amount of materials.

**Learning environment:** Engage children in spatial exploration with materials that:

- Can be used for filling and emptying (continuous materials for pouring, discrete materials that can be held, containers and scoops of all kinds)
- Fit together and come apart (commercial goods such as Legos® and Tinkertoys®; household items such as boxes and lids, bottles and tops, jewelry and clothing with different types of fasteners)
- Can be shaped and arranged (blocks, clay, rubber bands, rope, pipe cleaners, ribbons)
- Can be set in motion (things with wheels; things that roll, spin, and drip; equipment that moves in a predictable path like swings, merry-go-rounds, and seesaws)
- Can be used to draw and write — Children gradually become aware of *composition* in their artwork. Computer drawing programs allow them to think of objects in relation to one another.
- Provide pictorial representations — Children enjoy depictions of familiar situations. Keep a camera handy to document the stages as children transform something (e.g., a block structure). Photograph an object or event from different angles to encourage an awareness of perspective.

**Daily routine:** To focus on spatial awareness throughout the day:

- Allow time for children to explore and work with materials on their own.
- Encourage children to talk about how they made things.
- Encourage children to crawl, roll, bounce, and lie on their backs to view the world from different perspectives.
- Take walks so children get a sense of the school in relation to other neighborhood landmarks and see the same thing from different viewpoints.
- Value clean up time. Storing things in the proper orientation and location is spatial education.

**Adult-child interaction:** To acknowledge and build on children’s spatial reasoning:

- Imitate children’s actions and join them in a variety of positions.
- Accept repetition as an important part of exploring and discovering spatial principles.

- Allow children to solve spatial problems their own way. For example, when the roof of Erica's block structure kept falling down, she built an interior wall to hold it up instead of pushing the outer walls closer together. Her teacher Linda was tempted to tell Erica to just get a longer block, but Erica learned something by solving the problem her own way.
- Instead of giving directions, take directions from children. They love to lead. Following their instructions encourages the use of words related to position, direction, and distance.

## TIME

Preschoolers deal with time concretely. They miss an absent friend, grow bored, and get angry when told to stop doing something before they are ready. Adults measure time objectively, using clocks and calendars. Preschoolers measure time subjectively at first; but as they form mental representations, they are increasingly able to see time in more symbolic ways too. They can remember the past and anticipate the future. They become aware of sequence and pacing.

**Learning environment:** Think of time in physical terms to supply young children with appropriate materials and experiences.

- Provide materials that children can use to signal stopping and starting. Timers enrich play and also help resolve turn-taking conflicts. Other ideas include stop signs, musical instruments and tape recorders, and computer games that call for starting and stopping actions on signal.
- Provide materials children can set in motion. Materials that foster spatial awareness are equally effective in promoting temporal awareness. Objects that fall, roll, drip, spin, or rock in space can also be used to explore *fast* or *slow* and other time concepts. Each movement becomes a concrete way for young children to measure the units and passage of time.
- Include living things indoors and outdoors to show natural cycles of plant and animal life. Take photos to help children describe and reflect on the changes over time.

**Daily routine:** A consistent daily routine is the single most important element in developing time concepts. To help call attention to the routine:

- Signal the beginning and end of time periods (e.g., a chant that announces five minutes until clean-up). Predictability gives children a sense of anticipation and control over their lives.
- Inform children about changes in the routine. The exception calls attention to the norm. Also, alerting them re-establishes

their sense of control and allows them to deal with any anxieties.

- Sing, dance, and play musical instruments. These activities provide many chances to stop and start or comment on whether sounds and motions last for a short or long time.
- Encourage children to move at different rates. Reenact stories incorporating different rates of music. During transitions, ask children to move to a new area or activity at different speeds.
- Encourage children to take care of their own needs. For example, pouring juice allows children to gain control over their own fast and slow actions.
- Encourage children to describe their intentions and activities in time-related language. Ask them to plan the sequence in which they will do something: "What will you add next?" Ask if they did something fast or slow: "Did it take longer to carry the blocks or to stack them?"

**Adult-child interaction:** Listen to how children understand time to scaffold further learning.

- Comment on the speed with which things happen: "When you added another block at the top of the ramp, the cars rolled down faster."
- Relate lengths of time to familiar actions or events. When children ask, "How long until . . ." answer them with concrete markers: "I'll look at your picture when I finish reading this book to Yolanda," or "It will be clean-up when the big hand points straight down."
- Call attention to seasonal changes.
- Celebrate special occasions *if and when* they are meaningful to children. Just because a date has passed on the calendar, it doesn't mean a child is ready to let it go. Be prepared to play *trick or treat* at Thanksgiving or reenact Carla's fourth birthday party for several weeks.

## STAFF DEVELOPMENT

Teaching math does not come easily to many of us. Math phobia, poor preparation, and other factors all play a role. However, there are concrete things we can do to surmount these barriers.

**Overcoming math phobia.** When you accept that math for young children is more than numbers — that it involves logical operations like sorting and matching, arranging by size, dealing with space and time — you realize you do these things every day in your own life. Suddenly, math is not so esoteric and abstract. You don't have to be Einstein to teach math. In fact, when you're working with preschoolers, it probably helps to be grounded in ordinary, concrete reality.

# BEGINNINGS WORKSHOP

**Providing resources.** In the absence of scripted lessons, use other resources to make math part of the classroom. The standards and guidelines of the National Council of Teachers of Mathematics (NCTM; [www.nctm.org](http://www.nctm.org)) and publications of the National Association for the Education of Young Children (NAEYC; [www.naeyc.org](http://www.naeyc.org)) are good starting points. Read the joint NCTM-NAEYC position statement on early math education (2002), which contains these principles:

- Informal learning does not mean education is unplanned or haphazard. Teachers can be trained to intentionally and systematically incorporate math in the daily program routine.
- True learning is neither short-term nor rote. Math — like literacy or any other content area — should be embedded in the context of real and meaningful experiences.
- Children need a materials-rich environment to manipulate and explore math concepts.
- Technology — if used age-appropriately — can be one component of early math education.
- Children need time to construct, test, and reflect on their ideas about math.
- Natural conversations with adults help children extend their thinking about math.
- Staff development is critical to high quality program implementation.
- The purpose of assessment is to gain information for teaching, not to sort children.

The joint NAEYC-NCTM statement emphasizes that “providing good beginnings does not mean pushing down into the early years curriculum materials and teaching practices that are more effective for older children.” It is our job to make sure that early math education embraces the characteristics of good early education in general — an understanding of child development, support for staff development, meaningful involvement of families, research-based curriculum and pedagogy, continuous assessment, and respect for everyone in the educational community.

## REFERENCES

Gardner, H. (1991). *The unschooled mind: How children think and how schools should teach*. New York: Basic Books.

Hohmann, M., & Weikart, D. P. (2002). *Educating young children: Active learning practices for preschool and child care programs*. Second edition. Ypsilanti, MI: High/Scope Press.

National Association for the Education of Young Children and National Council of Teachers of Mathematics. (2002, April). *Early Childhood Mathematics: Promoting Good Beginnings*. A joint position statement of NAEYC and NCTM. Washington, DC: National Association for the Education of Young Children.

## Using Beginnings Workshop to Train Teachers by Kay Albrecht

**Five areas of math learning:** Epstein describes five key areas for math learning (see, p. 42) and then gives teachers many good ideas about how to incorporate these ideas into their children’s experience. Take the list of ideas in each area and turn them into an observation checklist to enable teachers to self-assess the level of math learning that is currently going on in their classrooms. Once the observations are complete, convene a staff meeting for teachers to consider what they found out and make action plans to increase mathematical experiences.

**Collections, and more:** Many of the ideas Epstein suggests require good collections of materials. Start collecting, scrounging, and purchasing a good collection of materials that encourage mathematical reasoning and exploration. Begin by doing a quick inventory of what you have. Then, have teachers peruse catalogs to search for ideas. Involve the children in collecting things, and your collection of collections will grow exponentially!

**The importance of routine:** The idea that the sequence of the day is the foundation of young children’s time concepts suggests that a classroom schedule is important and worth taking another look at. Invite teachers to re-assess the sequence of their daily schedule, making sure they are including the elements suggested in the article.

**Math phobias?:** Are your teachers confident of their mathematical knowledge? Epstein highlights the importance of logical operations — the ability to figure things out — a typical teaching strength in early childhood educators. If your teachers are not as confident as they would like to be, work together to understand and learn the ideas, concepts, and skills necessary to provide the concrete experiences that preschool children need.