Counting

Counting is a part of young children’s daily life. They love to count everything from the stairs they climb to the crackers they eat. But what is counting? What is there to be understood about counting? What do most children know about counting? What more is there to be learned? Counting seems very simple; but it is really quite complex. By developing a sophisticated sense of what counting is and what kind of counting we ought to emphasize in teaching, parents and teachers can better assist children with the development of counting skills and mathematical thinking.

Number Sense

Number sense is the ability to understand the quantity of a set and the name associated with that quantity. Strong number sense developed in the early years is a key building block of learning arithmetic in the primary grades, as it connects counting to quantities, solidifies and refines the understanding of more and less, and helps children estimate quantities and measurements.

Spatial Relationships

Children between the ages of 3 and 6 are more than ready to develop their skills at expressing directions from different locations and understanding relative positions. They are fundamentally interested in modeling their world, whether in the block corner or the housekeeping area, and spatial relationships are a large part of what they grapple with there. The more such experiences they have, particularly in the company of adults who help to mathematize them, the easier it will be to make their own representations of space mathematically precise when they get to geometry class.

Number Operations

When children focus on what happens when we join two sets together or separate a set into parts, they learn about how quantities change. When they have lots of experience comparing amounts, they become familiar with thinking about differences between sets. And when they have opportunities to see how a single large set can be composed of two or more smaller sets, they get comfortable with the fact that larger numbers contain smaller numbers. These ways of mentally modeling real situations are what we mean by number operations.

Sets

Sets are basic to children’s thinking and learning. They are also basic to our number system. One of the most important jobs of each number is to describe “how many” there are in a set of things—be it one, seven, or three hundred and nineteen. Before we can figure out how many apples there are, we have to decide which things are apples, and which are not. Once we’ve created the set of things that are apples, perhaps by separating them from the oranges, then we can count them. Counting requires a set, and as a result, the properties of sets have a large influence on the number system, and on mathematics.
**Data Analysis**

Data analysis can be very simple, like making a list of items and writing how many you have of each in parentheses, or creating and talking about a bar graph whose bars are higher for snowy than rainy days in the month of January. Whether the process involves specialized statistical software or markers and chart paper, what remains the same is that data analysis gathers information in a quantitative way (how many?), and then organizes it in some way that makes comparison and generalization possible.

**Measurement**

Measurement is any process that produces a quantitative description of an attribute, such as length, circumference, weight, temperature, volume, or number. Measurement is an essentially mathematical procedure that we apply in many different contexts. In our daily life, we often wish to know how many beats per measure, how many more minutes until preschool is over, how hot it is today, or whether I am taller than my friend. In all these circumstances, we use some kind of comparison process to measure or to answer the question “how much?” or “how many?” Attributes like length and capacity are more readily apparent and meaningful to young children than less visible ideas like temperature and time.

**Shape**

Everything in the material world has shape. In mathematics, the focus is very much on regular shapes, such as the two-dimensional circle, triangle, and rectangle and the three-dimensional solids known as spheres and polyhedrons. In our everyday world, these solids commonly appear in objects we describe as boxes, pyramids, blocks, cylinders, and balls. A deeper knowledge about how two- and three-dimensional shapes are defined and relate to one another will help educators be aware of subtle distinctions and rules. Such an understanding allows educators to notice and highlight children’s key discoveries and to guide their experiences to make this knowledge explicit for them.

**Pattern**

Pattern is less a topic of mathematics than a defining quality of mathematics itself. Mathematics “makes sense” because its patterns allow us to generalize our understanding from one situation to another. Children who expect mathematics to “make sense” look for patterns. Children need many opportunities to discover and talk about patterns in mathematics. These experiences help them form the attitude and confidence that mathematics should make sense, the crucial foundation all children need to become persistent and flexible problem solvers.

Source: http://earlymath.erikson.edu/foundational-concepts/

# Mathematical Games and Puzzles

*Developing Reasoning, Understanding, and Curiosities*

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<tr>
<th>Name &amp; Description</th>
<th>Mathematical Curiosities</th>
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<tr>
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<td>• What curiosities might arise for you and your students? (I wonder, What if, Why questions)</td>
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<th>Foundational Math Concepts</th>
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<td>• What understandings of math concepts are being involved or developed?</td>
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<th>Math Skills</th>
<th>Purposeful Questions for Skills</th>
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<td>• What math skills are involved/ being developed?</td>
<td>• What questions will you pose to assess and advance skills?</td>
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<th>Equitable Engagement and Access</th>
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<td>• What socio-emotional challenges might surface?</td>
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<td>• How might I create a safe space for math learning and struggle?</td>
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<td>• What steps ensure each student gets the opportunity to engage in deep math thinking (without being blocked by others)?</td>
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<td>• How will I ensure all students can enter into the math ideas?</td>
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<td>• What scaffolds might I provide additional supports or further challenge?</td>
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<td>• What barriers might need to be addressed (e.g., children’s experiences, language, cognitive needs)?</td>
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<th>Best Use</th>
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<td>How do you think you could best use this game?</td>
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Getting Curious About Curiosity
Selected Excerpts for Strong Start Math Summer Institute 2016

Reading One
Excerpts from:

How Can Teachers Foster Curiosity?
By Erik Shonstrom
June 4, 2014
Education Week

http://www.edweek.org/ew/articles/2014/06/04/33shonstrom.h33.html?tkn=VUTFPXYFFjLGC8Rqpw4pkjk+IzqTXjpklSx&print=1

Commentary

Fostering curiosity is key to learning, yet it’s difficult to achieve in the classroom. This is in part because curiosity itself is so misunderstood. While we can change pedagogy or curriculum, for the most part, students who want to learn, will. It is usually because they’re curious.

Because all students can learn, much of the educational reform has been dedicated to bolstering numbers in the “meets expectations” category of student assessment. We have lost sight of an important clue in helping our students succeed—that curiosity is an essential ingredient to wanting to learn.

Students who do well in school are often curious or ambitious. I’d argue that the best learners—a term not necessarily synonymous with “best students”—have curiosity in abundance. Ambition can come from parental pressure and cultural expectations, and be resented, tinging learning with negativity. And, while curiosity can inspire learning, it can also be an impediment. Curious students can act impulsively and intensely.

What is curiosity? The word is associated with the irregular form of the Latin verb cura, which can mean worry or care about or cure. The closest in meaning is inquisitive, which also has a Latin root: quaere, to search into, to seek.

Curiosity is a seeking and an exploration. No matter what branch of etymological tree is climbed, a striking theme becomes clear: Curiosity is not about finding, but about exploring. It almost has a spiritual sensibility about it, as though to be curious is to embrace a Buddhist koan— the path is the goal; the goal is the path.

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1 koan: A koan is a riddle or puzzle that Zen Buddhists use during meditation to help them unravel greater truths about the world and about themselves.
Research supports this view. In 1994, George Loewenstein, a professor of economics and psychology at Carnegie Mellon University, wrote an overview of curiosity literature for Psychological Bulletin, an American Psychological Association journal. Loewenstein noted curiosity has three attributes: intensity, transience\(^2\), and associations with impulsivity. All three are pejorative\(^3\) terms in the traditional classroom. Loewenstein also referenced studies from The Journal of Educational Research in which an elementary student’s curiosity is defined as thus: a child “reacts positively to new, strange, incongruous, or mysterious elements in his environment by moving towards them, exploring them, or manipulating them…he scans his surroundings seeking new experiences.”

Curiosity is inherently dynamic and propulsive, not sedentary and passive. Most traditional instruction depends on the latter state and seeks to control the former. This is true especially of the interrupting student or precocious child who wanders about, ignoring the lesson while remaining intent on some mission of his or her own. As Loewenstein stated: “Curiosity tends to be associated with impulsive behavior. People who are curious not only desire information intensely, but desire it immediately and even seek it out against their better judgment.”

Curiosity, it can appear, is a luxury the poor can ill afford; better for them to buckle down and get the basic, requisite skills to bootstrap themselves out of poverty and into gainful employment.

School could be a place for all students to experience unrestricted curiosity, but it isn't.

For students to be curious, they must feel worthy of seeking. They must feel entitled to ask questions and encouraged to stray, to explore, to seek. But what about the children who have had their curiosity dulled by the digital age; or for whom time to wander and wonder isn't a reality; or who have more-demanding, practical concerns than being curious about the world? How can we help them?

The ones who want to learn are easy. The question that stares us in the face every day is how to help all students, especially those for whom curiosity is in short supply.

Counterintuitively, our role as teachers is not to provide answers. Our role is to give time and free rein to inherent curiosity and questions, and let our students exist in the heightened state of hungering for knowledge.

\(^2\) transience: short in duration; not permanently settled in place.
\(^3\) pejorative: disapproving
Curiosity—A Culture of Asking Questions

So, what is curiosity and how do students become more curious? The debate about curiosity -- its definition, how it gets activated and what exactly it does -- seems to be ongoing in psychology. My goal for this blog is to make you, the reader, curious about curiosity.

George Loewenstein (1994) proposes in his paper "The Psychology of Curiosity: A Review and Reinterpretation" that a knowledge-gap produces a feeling of deprivation, which he calls curiosity. Curiosity is the complex feeling and cognition accompanying the desire to learn what is unknown. He argues that the following factors will lead to the noticing of a knowledge-gap and hence curiosity:

• The posing of a question, riddle or puzzle
• Exposure to a sequence of events with an anticipated but unknown result
• The violation of expectations (something seems contradictory)
• Possession of knowledge by someone else
• Past knowledge that is now “just out of reach”

Loewenstein explains that a knowledge base is necessary and that the knowledge-gap has to be manageable to stimulate curiosity.

In a later paper Kang et al. (2009) showed in experiments that a higher level of curiosity had a strong effect on remembering the information. If you let students pursue what they are curious about (or set it up so that they feel curious about what you would like them to learn) they have a better chance of remembering the content. This is clearly contrary to the common belief that the only way to remember something is through mindless repetition. Additionally Mullaney et al. (2014) showed in experiments that delayed feedback to guessing will enhance long-term memory if the subjects were curious about the answer. Their result seems to support that students recall content better if we let them struggle to find their own answers without us giving immediate feedback.
What's in the Way?
Some of the emotions that can get in the way of inquiring and asking questions are fear and shame. We are part of a culture of knowing and it doesn’t feel good to admit that we struggle or don’t know. In fact, we often connect not knowing with being stupid. This does not need to be the case. Psychologist Prof. J. Stigler at UCLA reports in an interview with NPR\(^1\) that in Asian cultures struggle is seen as an opportunity, not a weakness or inability.

Shame of not knowing and fear of ridicule can get in the way of even wanting to wonder and hence of asking questions. Celebrating mistakes and creating a safe space for struggle helps students to leave the zone of anxiety. According to Day (1982), Berlyne’s theory of curiosity describes three zones: relaxation, curiosity and anxiety. Day claims that a student learns most efficiently in the zone of curiosity. In this context, "cool things" can bring students from a zone of relaxation into the zone of curiosity. Lively discussions and inquiry can keep students in a curious state. Especially in the beginning of the semester it is important to get students out of the zone of anxiety.

![Berlyne’s Zone of Curiosity](image)


http://www.npr.org/sections/health-shots/2012/11/12/164793058/struggle-for-smarts-how-eastern-and-western-cultures-tackle-learning
3 Ways to Foster Curiosity

An ability to be curious, to ask questions and have an open intrigue about the world is a more modern way of assessing intelligence than simply assessing known facts. Teachers now face the task of not just imparting knowledge but developing an insatiable appetite for learning in their pupils. But how do we stimulate in students, this continuous and lifelong desire for acquiring knowledge? We start by encouraging keen questioners and active thinkers in the classroom.

A perfect pupil may be defined as having many qualities: good behaviour, active listening, natural intelligence; the list goes on. But many educators are now citing “being unafraid to ask questions” as a key ingredient to the perfect pupil. With these three steps, we believe you can stimulate the curiosity that leads to children becoming life-long learners.

1. **Establish a safe rapport with children**  
   Children may not ask questions because they lack confidence, do not feel safe sharing their thoughts or fear getting it wrong. Create a safe environment, where questions are encouraged. Give children explicit thinking time ‘take 30 seconds to think about it’; use ‘talk partners’ so children can partner up and discuss their thinking with a less intimidating character than the teacher.

2. **Model how to ask questions and encourage them to answer their own questions**  
   Ask questions that will help develop children’s thinking, such as ‘What other examples might there be?’, ‘Can you expand on that?’, or ‘What else do you know?’

3. **Give time for children to ask questions**  
   Plan opportunities for children to pose any questions that may be on their mind. In a classroom situation, you may also plan to give pupils the ‘answer’ and get them to come up with the question.
References


