DMT INSIGHTS

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THE FIVE COUNTING PRINCIPLES: FROM COUNTING WORDS TO QUANTITY

What students coordinate when they count a set

Introduction

A child who can say “one, two, three, four, five” does not necessarily understand what it means to count five objects. Counting requires students to coordinate number words, objects, and quantity.

Gelman and Gallistel (1978) identified five principles that help explain what students understand when they count: one-to-one correspondence, stable order, cardinality, abstraction, and order irrelevance. Together, these principles help us distinguish reciting a sequence of number words from counting a set with understanding.

The five principles describe what successful counting requires, but researchers have debated how children come to understand these principles. One view is that the principles guide children’s development of counting procedures (Gelman & Gallistel, 1978; Gelman & Meck, 1983). Other accounts emphasize that children’s understanding develops as they learn the number-word sequence and connect those words to quantities (Briars & Siegler, 1984; Fuson, 1988; Wynn, 1990). Across these perspectives, the distinction between reciting number words and using those words to determine quantity remains important (Le Corre et al., 2006).

For teachers, the important question is not simply, “Can the student count?” It is, “What does the student’s counting tell us about what the student understands?”

> **Key Idea • Counting is not simply saying number words in order. Students coordinate a number word with each unit, maintain the counting sequence, and understand that the final number names the set's quantity.**

What Are the Five Counting Principles?

- **One-to-one correspondence.** Count each object once and assign it one number word.
- **Stable order.** Number words are used in a consistent sequence.
- **Cardinality.** The final number word tells how many objects are in the set.
- **Abstraction.** Different kinds of objects, actions, sounds, or events can be counted as units.

- **Order irrelevance.** Objects can be counted in a different order without changing the quantity, as long as each object is counted exactly once.

Gelman and Gallistel distinguished three principles of counting: one-to-one correspondence, stable order, and cardinality. Abstraction and order irrelevance address what can be counted and how the objects in a set may be selected during a count.

These principles work together. A student may know the counting sequence but not yet coordinate one number word with each object. Another student may count every object correctly but not understand that the final number tells how many are in the set. Watching how students count helps identify which relationship is developing.

> **Key Idea • The five principles work together. Watching how a student counts shows which relationship is developing.**

Counting Units

From a DMTI perspective, the five principles also raise a structural question: What counts as one? To count, a student must identify the units being counted. Each object, sound, movement, or event can function as a unit. The counting sequence then iterates that unit: one more unit, one more unit, one more unit.

This idea of unit extends well beyond early counting. Students later count units of ten, equal groups, fractional units, units of measure, and other quantities.

> **Key Idea • To count, a student must determine what counts as one.**

What Student Counting Can Reveal

A student's counting shows more than whether the final answer is correct. Not every difficulty is a misconception. Some are errors, some reflect incomplete counting knowledge, and some reflect difficulty coordinating number words, objects, and quantity. Each observation gives teachers different information about what the student understands.

- **A student skips or repeats a number word.** Look at stable order. A student might count "1, 2, 3, 5, 6" or "1, 2, 3, 3, 4, 5" (Fuson, 1988).
- **A student counts an object twice or misses an object.** Look at one-to-one correspondence. The number words may be in order while the words and the objects are not yet coordinated. These errors become more frequent as sets become larger (Fuson, 1988).
- **A student counts five objects correctly, but when asked "How many?" begins counting again.** Look at cardinality. Bermejo and Lago (1990) proposed six levels in children's understanding that the final number word refers to the whole set, and Bermejo (1996) gathered empirical evidence on those levels.
- **A student has difficulty counting sounds, actions, or a mixed set of objects.** Look at abstraction. The student may not yet treat each sound, action, or object as a unit to be counted (Gelman & Gallistel, 1978).
- **A student thinks counting from the other side changes the answer.** Look at order irrelevance. Baroody (1993) found that many preschoolers could count a set in a different order and still did not predict that the second count would give the same number.

- **A student thinks spreading the objects apart creates more.** This observation concerns conservation of quantity, which should be distinguished from the five counting principles.

Conservation of quantity is related to, but not identical with, the five counting principles. A student who believes that spreading a set of counters apart creates more has not yet established that the quantity remains equal when only the arrangement changes (Piaget, 1952).

> **Key Idea • How a student counts shows which relationship is still developing.**

Subitizing and Counting

Subitizing is recognizing the quantity of a small set without counting each object (Clements, 1999). It is not another counting principle. It is a different way of determining quantity. When students recognize small quantities without counting, those quantities can become units for later reasoning. For example, a student may recognize four and then count on two more rather than count all six objects from one.

Cardinality: Connecting the Count to the Quantity

Cardinality is more than remembering the last number said. The student must understand that the final number word represents the quantity of the whole set. This connection develops over time. A child may produce a correct counting sequence before understanding what the final number means.

Wynn (1990, 1992) asked young children to give a requested number of objects. Many children who could count a set aloud could not use counting to produce the number requested. They learned the meanings of “one,” “two,” and “three” one at a time before they used counting for larger numbers. Sarnecka and Carey (2008) found that only children who applied the cardinal principle understood that adding one object to a set means moving to the next number word. A recent replication found that children acquire these meanings gradually, over a longer period than Wynn described (Rousselle & Vossius, 2021).

This distinction helps explain why asking “How many?” after a count can be so informative. A student who immediately gives the final number is doing something mathematically different from a student who begins the count again. The final number alone is not conclusive, because some children learn to repeat the last word of a count before they understand that it names the quantity (Wynn, 1990).

> **Key Idea • Cardinality connects the count to the quantity. The final number word names the whole set.**

Counting Forward and Backward

Reciting the counting sequence and counting a quantity are different, and students need both. Fuson (1988) describes the number-word sequence becoming more flexible over time. At first, students can produce the sequence only by starting from one. Later, they can start from any number, and later still they can count in either direction.

Counting backward requires students to produce the number sequence in a less familiar direction and can reveal how well the sequence is organized. This flexibility in the number-word sequence becomes useful as students begin counting on and counting back in addition and subtraction situations.

Key Idea • Reciting the counting sequence and counting a quantity are different. Students need both.

Language for the Mathematics Students Are Doing

Mathematical language should describe relationships students are already acting on. When students count, teachers can draw attention to the unit being counted, the quantity in the set, what changes when one more unit is added, and what stays equal when a set is rearranged.

The goal is not to teach structural words as vocabulary. The goal is to give students language for the mathematics they are already doing. Research with 3- to 5-year-olds found that mathematical language was related to numeracy performance even when general language was included in the analysis (Purpura & Reid, 2016).

Key Idea • Give students language for the mathematics they are already doing.

Representations That Make Counting Visible

Bruner (1966) described three ways of representing knowledge: through action, through images, and through symbols. Students should have opportunities to act on quantities, represent them, and connect those representations to number words and symbols. These representations do not need to occur in a fixed sequence. The important question is whether the representation makes the quantity and the counting relationship visible.

Different representations reveal different relationships. Collections of objects can make one-to-one correspondence visible. Ten-frames organize quantities around benchmarks of 5 and 10. For example, 7 can be seen as 5 and 2 more, rather than as seven unrelated objects. Number paths and number lines connect the counting sequence to order and magnitude. Bar models can represent a total and its parts as students begin composing and decomposing quantities.

Number lines can also represent numerical magnitude. Siegler and Booth (2004) documented developmental changes in young children's numerical estimation on number lines.

Key Idea • A representation earns its place when it makes the quantity and the counting relationship visible.

Questions That Reveal Counting

Asking a student to count shows whether the count is correct. Questions such as the following show more about what the student understands.

- What are you counting?
- How will you make sure you count each one once?
- How many are there in total? How do you know?
- If we start counting over here instead, will there still be the same number? Why?
- If I move these farther apart, does the quantity change?
- What would happen if I added one more?
- What number comes before? What number comes after?

Each question highlights a different relationship: the unit being counted, the correspondence between number words and objects, the set's quantity, and what stays equal when the order or arrangement changes.

> **Key Idea • These questions reveal much more than simply asking a student to count.**

A Developmental Progression

Research on early number describes counting as developing along a general path (Clements & Sarama, 2014; Frye et al., 2013). Drawing from this research and DMTI's work with learning progressions, we organize the development as follows:

Compare quantities → coordinate one number word with each unit → maintain stable order → connect the final number to the total quantity → count sets arranged in different ways → count on from a known quantity → count backward → count by equal units → compose units into larger units.

This is a developmental progression, not a rigid sequence. Students may demonstrate several of these ideas at the same time and move back and forth as the quantities and contexts change.

Counting on is one example. Students first solve addition problems by counting all of the objects in both sets. Later, they begin with one quantity and count on (Carpenter & Moser, 1984)—a student who counts on treats the first quantity as already counted, which depends on cardinality. Counting on therefore shows why cardinality matters beyond simply answering "How many?"

> **Key Idea • This is a developmental progression, not a rigid sequence.**

From Counting Ones to Counting Units

Counting eventually extends from units of one to composed units. Ten units of one can be composed into one unit of ten. Ten units of ten can be composed into one unit of one hundred. The counting principles still matter, but the unit being counted changes.

This is an important bridge from counting to place value: students are no longer counting only ones. They are counting units of different sizes.

The structure remains: identify the unit, iterate that unit, and determine the quantity. What changes is what counts as one.

> **Key Idea • The counting principles still matter. The unit being counted changes.**

Conclusion

Counting is one of the first places students coordinate units, number words, and quantity. The five counting principles help teachers see what students understand within an activity that can otherwise look simple.

A student who can recite the counting sequence may not yet count a set accurately. A student who counts accurately may not yet understand that the final number represents the total quantity. Looking closely at these differences gives teachers better information about what comes next in mathematics.

Students continue to count throughout mathematics. What changes is the unit: ones, tens, equal groups, fractional units, units of measure, and more. The recurring question is simple: What counts as one?

> **Key Idea • What counts as one? The question returns each time the unit changes.**

References

Baroody, A. J. (1993). The relationship between the order-irrelevance principle and counting skill. *Journal for Research in Mathematics Education, 24*(5), 415–427.

Bermejo, V. (1996). Cardinality development and counting. *Developmental Psychology, 32*(2), 263–268.

Bermejo, V., & Lago, M. O. (1990). Developmental processes and stages in the acquisition of cardinality. *International Journal of Behavioral Development, 13*(2), 231–250.

Briars, D., & Siegler, R. S. (1984). A featural analysis of preschoolers' counting knowledge. *Developmental Psychology, 20*(4), 607–618. https://doi.org/10.1037/0012-1649.20.4.607

Bruner, J. S. (1966). *Toward a theory of instruction*. Harvard University Press.

Carpenter, T. P., & Moser, J. M. (1984). The acquisition of addition and subtraction concepts in grades one through three. *Journal for Research in Mathematics Education, 15*(3), 179–202.

Clements, D. H. (1999). Subitizing: What is it? Why teach it? *Teaching Children Mathematics, 5*(7), 400–405. https://doi.org/10.5951/tcm.5.7.0400

Clements, D. H., & Sarama, J. (2014). *Learning and teaching early math: The learning trajectories approach* (2nd ed.). Routledge.

Frye, D., Baroody, A. J., Burchinal, M., Carver, S. M., Jordan, N. C., & McDowell, J. (2013). *Teaching math to young children: A practice guide* (NCEE 2014-4005). National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Fuson, K. C. (1988). *Children's counting and concepts of number*. Springer-Verlag.

Gelman, R., & Gallistel, C. R. (1978). *The child's understanding of number*. Harvard University Press.

Gelman, R., & Meck, E. (1983). Preschoolers' counting: Principles before skill. *Cognition, 13*(3), 343–359. https://doi.org/10.1016/0010-0277(83)90014-8

Le Corre, M., Van de Walle, G., Brannon, E. M., & Carey, S. (2006). Revisiting the competence/performance debate in the acquisition of the counting principles. *Cognitive Psychology, 52*(2), 130–169. https://doi.org/10.1016/j.cogpsych.2005.07.002

Piaget, J. (1952). *The child's conception of number*. Routledge & Kegan Paul.

Purpura, D. J., & Reid, E. E. (2016). Mathematics and language: Individual and group differences in mathematical language skills in young children. *Early Childhood Research Quarterly, 36*, 259–268.

Rousselle, L., & Vossius, L. (2021). Acquiring the cardinal knowledge of number words: A conceptual replication. *Journal of Numerical Cognition, 7*(3), 411–434. https://doi.org/10.5964/jnc.7029

Sarnecka, B. W., & Carey, S. (2008). How counting represents number: What children must learn and when they learn it. *Cognition, 108*(3), 662–674. https://doi.org/10.1016/j.cognition.2008.05.007

Siegler, R. S., & Booth, J. L. (2004). Development of numerical estimation in young children. *Child Development, 75*(2), 428–444.

Wynn, K. (1990). Children's understanding of counting. *Cognition, 36*(2), 155–193. https://doi.org/10.1016/0010-0277(90)90003-3

Wynn, K. (1992). Children's acquisition of the number words and the counting system. *Cognitive Psychology, 24*(2), 220–251.

Social Media

A child can say the counting sequence correctly and still not understand what it means to count a set.

The five counting principles explain what students coordinate when they count: one number word for each unit, a stable number sequence, the total quantity, what can be counted, and why the order of counting does not change the total. Inside this DMT Insight, we look at:

- What each of the five counting principles means
- What student counting can reveal
- The questions teachers can ask to determine what students understand
- How counting ones extends to counting units of ten

Read the full Insight at mathsuccess.io/dmtinsights.

When a student finishes counting a set, and you ask "How many?", what does the student do?


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