



Tales, Tasks, Tools, and Talk

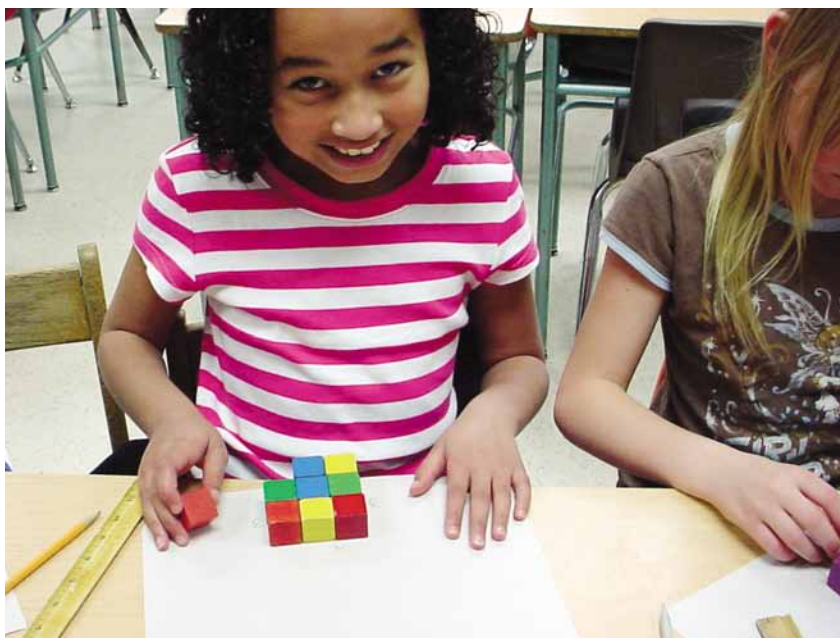
The title is written in a large, bold, black font, slanted upwards from left to right. To the right of the title, there are three illustrations: a green footprint, a blue footprint, a yellow measuring tape with black markings, and a brown caterpillar on a green leaf.

Engage children in literature to pique their interest in quantity concepts, develop their fluency in measurement processes, and establish their quantitative literacy.

By Timothy S. McKeny and Gregory D. Foley

The importance of a literacy-based approach to content learning, especially within elementary school grades, is not a new idea. During the past quarter-century, the use of children's literature as an effective teaching tool has gained popularity across all content areas (Thiessen 2004). The definition of literacy has expanded not only to include various print and nonprint media but also to incorporate quantitative literacy through the development of number, number sense, and measurement. As elementary school students engage and interact with text and illustrations and with storylines and characters that stir their imaginations, they enthusiastically blend context and reasoning in their problem solving. In a process of making sense of the world around them, they intrinsically link literacy and mathematics. Yet in many elementary schools throughout the United States, the literacy-mathematics connection is often not made (Altieri 2010).

BOY WITH BOOK: TATYANAGL/VEER; MEASURING TAPE: PICSFIVE/VEER; CATERPILLAR: DEFUN/VEER



JANIS TYSKO

basis for student-centered mathematics instruction in K–grade 5. Since 2006, BMTL has been successful in leading classroom teachers to integrate and contextualize reading and mathematics. Stories are fundamentally human, and children enjoy and remember good books. Stories provide a narrative structure and a meaningful context for the growth and development of mathematical thinking and language as young readers interact with memorable characters, meaningful settings, and engaging storylines. Further, blending mathematics with children’s literature increases students’ enjoyment of and motivation toward mathematics and reduces the potential for mathematics anxiety. The tasks used in BMTL are tied to the tales in children’s books, giving enhanced meaning to the phrase *story problem*.

Measurement

Well-chosen measurement activities from BMTL invite early-grade learners into the mathematical practices of sense making and reasoning through tales, tasks, tools, and talk. Measurement tasks engage children in thinking and talking about number and quantity through describing and comparing attributes of objects in the world around them. Through in-context activities, children learn about length and weight, time and temperature, area and volume. They learn how to compare and estimate these measurable attributes. They learn how to use cognitive tools (such as nonstandard and standard units) and physical tools (such as scales and rulers) to quantify measurements. Through small-group conversation and whole-class discourse, they learn how these tangible quantities relate to number, operations, and algebraic thinking.

The curriculum comes alive for young learners as they investigate mathematics in context, gather and use genuine data, and engage in measurement tasks. Measurement links to number, to algebra, to geometry, and to data while providing a portal to the critical mathematical practices of problem solving, reasoning, argumentation, modeling, and attention to precision. The following section highlights teaching tips and sample tasks from the BMTL project that develop students’ understanding of quantity and fluency in measurement for K–grade 5 within the context of children’s literature, writing, and communicating.

Youngsters learn how to use physical tools to quantify measurements and how these tangible quantities relate to number, operations, and algebraic thinking.

Integrating measurement tasks with children’s literature and classroom discourse builds a base for a quantitatively literate child. Providing opportunities for children to read, write, listen, and speak mathematically strengthens their connections among number, quantity, and symbol as well as linking language literacy and quantitative literacy. Foley, Strayer, and Regan (2010, p. 6) define *quantitative literacy* as “a form of general literacy” that combines numerical reasoning, measurement, statistical reasoning, modeling, and mathematical communication. We see quantitative literacy for children in K–grade 5 as a form of literacy closely coupled with many of the new Standards for Mathematical Practice: making sense of problems, reasoning quantitatively, constructing viable arguments and critiquing the reasoning of others, modeling with mathematics, using appropriate tools strategically, and attending to precision (CCSSI 2010).

Story problems

The Better Mathematics through Literacy (BMTL) project has convinced us that quantitative literacy can be developed in concert with general language literacy, cognitively engaging tasks, and purposeful classroom discussion. The BMTL project is a professional-development initiative that shows teachers and intervention specialists how to use children’s literature as a

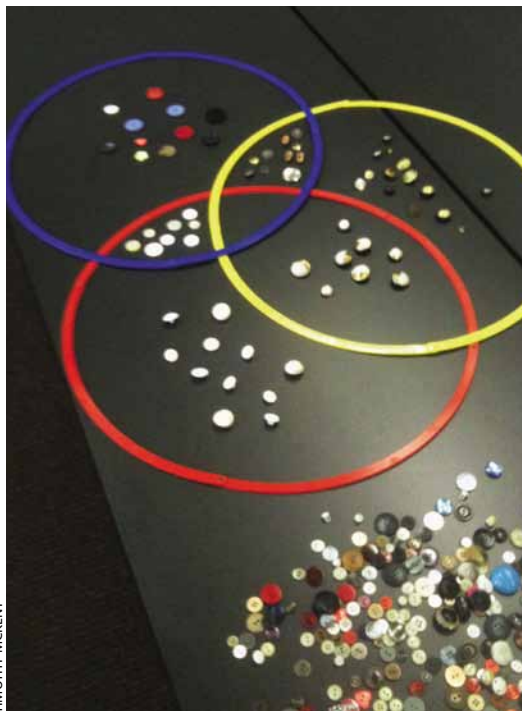
Making the connection

Measurement is one of five National Council of Teachers of Mathematics (NCTM) Content Standards (2000). Measurement has strong connections to other mathematical content domains. The role of measurement and its place in grade-by-grade curriculum are detailed in NCTM's (2006) *Curriculum Focal Points* and in the CCSS's (2010) Common Core State Standards for Mathematics (CCSSM). "Because mathematics as a discipline is highly interconnected, the areas described by the Standards overlap and are integrated" (NCTM 2000, p. 30). Due to this high level of connectivity, we often may be teaching measurement-related concepts without realizing it. By actively including measurement in our thinking and planning, and by capitalizing on the power of language literacy integrated with mathematics, we can help early-grade learners improve their understanding of measurement and establish a solid foundation to develop quantitative literacy more fully in later years.

"The study of measurement ... offers an opportunity for learning and applying other mathematics, including number operations, geometric ideas, statistical concepts, and notions of function" (NCTM 2000, p. 44). In fact, CCSSM recognizes these interrelationships as key steps in building quantitative literacy by connecting Measurement and Data as a single conceptual category for K–grade 5, by folding measurement across the categories in grades 6–8, and by including measurement within Number and Quantity in grades 9–12. Additionally, measurement fits naturally with sense making, reasoning, modeling, and other Standards for Mathematical Practice, all of which span K–grade 12.

Developing number, operations, and measurement through language

Little in a child's world is untouched by measurement. When establishing the groundwork for meaningful counting and cardinality, kindergartners might excitedly count heel-to-toe footsteps as they cross the length of their classroom, run races to see who is the fastest, or stand back-to-back to decide who is taller. But if we want students to become effective communicators and thinkers, we must provide opportunities for them to develop the language of measurement



TIMOTHY MCKENY

First and second graders develop a language of synonyms and antonyms and learn to sort objects on the basis of such attributes.

in conjunction with their experiences with number and operations. Considering all the events and objects that could be measured, strategic teachers combine young students' conceptual understanding of addition and subtraction with their need to acquire an understanding of measurable attributes—length, weight, time, area, volume (capacity)—and to compare measurements of the same attribute. For learners in the early grades, this could be done within the context of daily word work. Providing a measurement word wall as a classroom focal point not only builds familiarity with common attributes and units but also increases students' measurement vocabulary. In first and second grade, a great deal of emphasis is placed on language development of synonyms and antonyms and on sorting a variety of objects on the basis of such attributes as tall and short, wide and narrow, heavy and light, big and little. Sorting and comparing activities, as illustrated in *Grandma's Button Box* (Aber 2002), offer opportunities to learn measurement concepts, connect language with mathematics, and give context for the concepts of greater than and less than. Using words of approximation—such as about, nearly, and almost—can increase students' measurement lexicon while subtly reinforcing the concepts of estimation, precision, error, and uncertainty.

Students compare their estimates to the actual number of cups that an unmarked juice container holds.



The concept of unit analysis (dimensional analysis) also ties number, operations, and measurement to language. An important concept for children to learn is that when we add or subtract quantities, the attributes and units are preserved. For example, number sentences for computing length might look like the following:

$$10 \text{ m} + 10 \text{ m} + 3 \text{ m} = 23 \text{ m} \text{ or} \\ 29 \text{ ft.} + 12 \text{ ft.} - 17 \text{ ft.} = 24 \text{ ft.}$$

Such mathematical activity can grow naturally from reading *Inch by Inch* (Lionni 1960) as young students role-play the character of the inchworm, proud of their ability to measure anything under the sun.

Building estimation and algebraic thinking

A critical skill within the early grades is for students to understand and value the importance of estimation when making measurements and doing calculations:

One of the best ways for children to think of real quantities is to associate numbers with measures of things. In the early grades, measures of length, weight, and time are good places to begin. (Van de Walle and Lovin 2006, p. 58)

Estimation can serve a dual purpose by both focusing students' attention on the attribute being measured and serving as a way to

determine reasonableness when adding and subtracting.

Leading students to make reasonable estimates before using standard or invented calculation strategies is often overlooked in the context of measurement. Asking students, for example, to estimate how many stacked cookies it would take to equal the height of a cookie jar draws their attention to one aspect of the container, develops number sense, and requires them to compare the attribute of the unit to the attribute of the object. With enough personal experiences in estimating and measuring, children develop familiarity with measurement units and learn to estimate using reasoning and sense making rather than haphazard guessing.

Great Estimations and, for older readers, *Greater Estimations* (Goldstone 2006, 2008) are books with excellent contexts to build estimation skills. Training students to see groups of tens, hundreds, and thousands through clustering or through boxing and counting prepares them to acquire visualization and estimation strategies that are applicable to other contexts while reinforcing the concept that small units can be combined into larger units that can measure the same quantity. Making estimations could be expanded readily to small-group and whole-class experiences through a Great Estimations contest in which students explain their estimates for the lengths of unmarked ropes, the number of gummy bears in a glass container, the weight of a rock from the playground, or the number of cups in an unmarked juice container. This contest encourages the skillful use of estimating; provides an intrinsic motivation to come closest to the actual value; and involves problem solving, reasoning, and verbal and written communication.

Making extensions

Although some geometry concepts can be quite abstract, young students can begin to recognize, analyze, compare, and reason with shapes as they engage in personal experiences that are natural extensions of shared stories from their language arts learning. Geometry has its roots in measuring the world and its parts, and through activity and collaboration, young learners come to construct their understanding of shapes as well as the units we use to measure the attributes of shapes.

A key goal of measurement instruction is to build familiarity and flexibility to think and reason with standard units of measurement. However, without prior experiences in exploring the instability and uncertainty of nonstandard units, children have little context for why standard units are needed. The use of nontraditional units leads students to notice that the size of a unit is important in reporting and recording measurements and provides a rationale for standard units.

Kindergarten students could investigate their immediate surroundings through multiple means after hearing *My Book about Me* (Seuss and McKie 1969). Small groups of students reconcile the discrepancies in their count of giant steps from the classroom door to the nearest water fountain or the number of library books necessary to equal the weight of the school principal. Older readers could enjoy the dilemma of using nonstandard units of length by reenacting the events of *How Big Is a Foot?* (Myller 1990): first they wear a college athlete's football cleats, then a teenage girl's ballet slipper, and finally a first grader's sneaker. After a whole-class read-aloud of *Measuring Penny* (Leedy 1997), students are energized and eager to use measurement to investigate the attributes of everyday objects and to brainstorm about attributes of the same object to measure using standard and nonstandard units. These contexts easily lend themselves to classroom publication of student-generated measurement books, an enjoyable way to bridge the seemingly separate worlds of mathematics and language.

Pairing children's literature with manipulatives can increase young students' understanding of shape and geometric transformations. Using tangrams in conjunction with *Three Pigs, One Wolf, and Seven Magic Shapes* (Maccarone 1997) allows students to re-create a familiar tale while building shapes from other shapes. Older children could investigate rotations and reflections in the natural world by using a MIRA with the beautiful illustrations within *Snowflake Bentley* (Martin 1998). Thus, a focus on geometric concepts and unit analysis in the early grades can develop the cognitive tools for children to achieve a deep understanding of dimension and proportion in the middle grades.

→ reflect and discuss

“Tales, Tasks, Tools, and Talk”

Reflective teaching is a process of self-observation and self-evaluation. It means looking at your classroom practice, thinking about what you do and why you do it, and then evaluating whether it works. By collecting information about what goes on in our classrooms and then analyzing and evaluating this information, we can identify and explore our own practices and underlying beliefs.

The following questions related to “Tales, Tasks, Tools, and Talk” by Timothy S. McKeney and Gregory D. Foley are to aid you in reflecting on the article and how the authors' ideas might benefit your own professional practice. Reflect on the article independently as well as discussing and using it with your colleagues. Then tell us how you used Reflect and Discuss as part of your professional development. Submit letters to *Teaching Children Mathematics* at tcm@nctm.org. Include Readers Exchange in the subject line. Find more information and submission guidelines at tcmmsubmit.net.

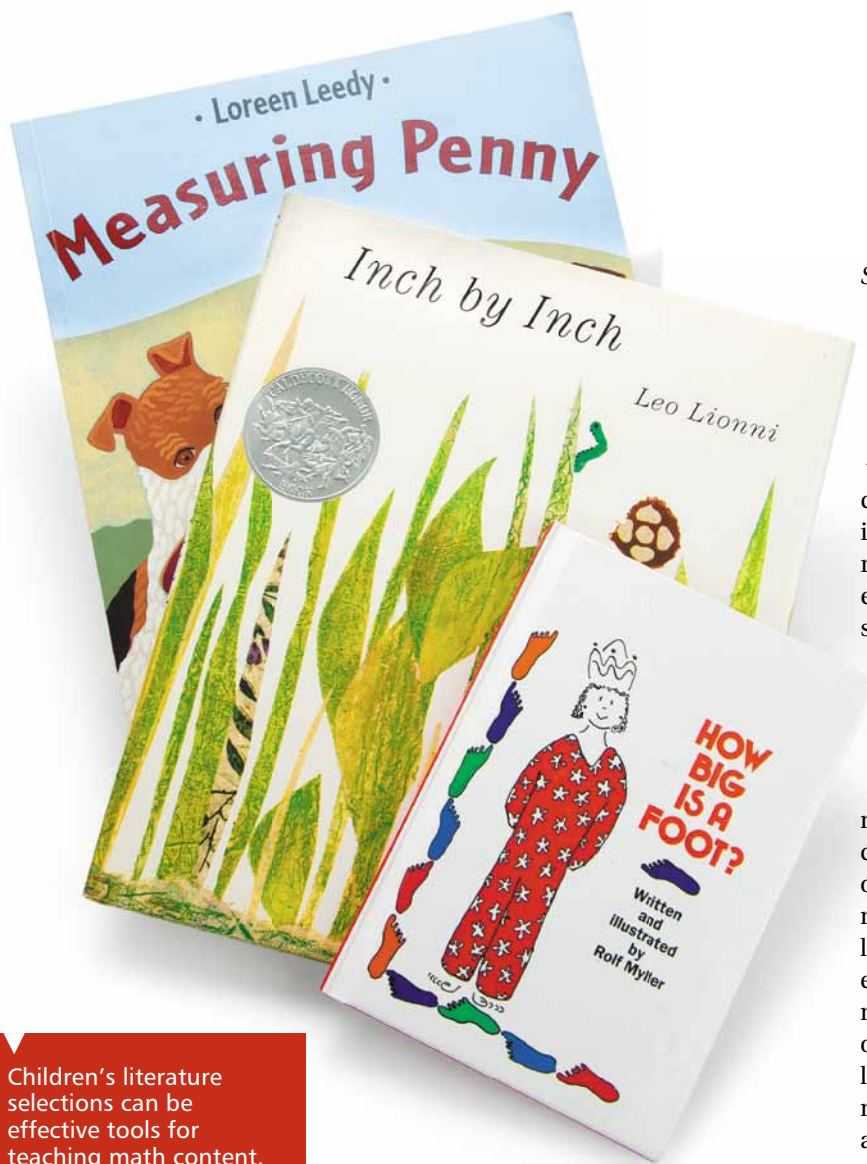
1. Select one of the integrated measurement tasks from the article. Then, using the Common Core State Standards for Mathematics (CCSS), identify which Standards for Mathematical Practice the activity addresses. Discuss your thinking and your reasoning with your colleagues.
2. Do the same activity again, but use the Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects.
3. Use the reading curriculum currently in place within your school or district to select three “nonmathematical” pieces of children's literature. Brainstorm with your colleagues about using the characters, setting, and storyline of each of the selected pieces of literature to create or design measurement concepts and measurement activities similar to the ones presented in the McKeney and Foley article.
4. According to NCTM,

to equip students to deal with diverse situations in science and other subject areas, and to prepare them for life in a global society, schools should provide students with rich experiences in working with both the metric and the customary systems of measurement while developing their ability to solve problems in either system. (NCTM 2006b)

How do you address this issue in your classroom? How could using literature help us deal with the two systems of measurement used in the United States? Discuss your reasoning with other teachers in your building.

Integrating data, measurement, and poetry

Statistics expands the concept of variable to include categorical variables, such as eye color, favorite food, or type of household pet, which involve counting. However, most data collection involves measurement. Children in K–grade 5 are inherently interested in such data collection activities, which emphasize the interrelationships of measurement and data. In fact, CCSSM treats them as a single content domain for K–grade 5.



The poem “One Inch Tall” from *Where the Sidewalk Ends* (Silverstein 2004) presents a delightful opportunity to connect language and measurement. After experiencing the poem in a classroom setting, students could begin to talk about other things that would be easy or difficult to do if they were one inch tall. From this brainstorming, young students could generate their own poems and narratives in which they articulate their personal frames of reference for these measurement units. An easy extension is for students to assume other perspectives by considering similar circumstances and other heights for the poem’s narrator.

Removing artificial boundaries

The famous Renaissance astronomer Johannes Kepler is attributed with saying, “To measure is to know.” Measurement gives young children a way to explore and to make sense of their world. Within an elementary school mathematics classroom, purposefully designed lessons and activities could be enriched and enlivened by infusing them with quantity and measurement and placing them within the overarching context of children’s literature and language literacy. Thoughtfully integrating mathematics and literacy instruction removes artificial boundaries between content areas so that students become motivated problem solvers of contextual tasks, have opportunities to communicate and represent their mathematical thinking in multiple ways, and construct a vibrant understanding for knowing and doing mathematics.

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Children’s literature selections can be effective tools for teaching math content.

Students in later grades often have difficulty interpreting and analyzing quantitative data because they do not have strong mental representations of the standard units of measurement. For example, a middle-grades student cannot begin to process the concept of a rectangular perimeter of 28 meters when the student has no idea how big or how small a meter actually is. Beginning in K–grade 5, students could develop personal frames of reference for common units of measurement that will serve them well for years to come.

An engaging activity for first- and second-grade students is the Measurement Scavenger Hunt for common units. Post a classroom chart that lists frequently encountered standard units (e.g., gallon, pound, foot, gram, liter). Students could draw pictures and construct other representations that accurately quantify each category. This activity builds frames of reference and literacy skills by encouraging the careful reading of sight words and print media.

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Timothy S. McKeny, mckeney@ohio.edu, is an assistant professor of mathematics education at Ohio University and director of the Better Mathematics through Literacy project. His interests include professional development in early and middle childhood mathematics, the integration of mathematics and literacy in the early grades, and mathematics coaching.

Gregory D. Foley, foleyg@ohio.edu, is the Robert L. Morton Professor of Mathematics Education at Ohio University. He is a mathematics educator, researcher, and textbook author who studies language and literacy, inquiry-based instruction, and innovative uses of tools and technology for mathematics teaching and learning at all levels.