

Linear Measurement

What is it?

Measurement is both a concept and a process. A measurement is a comparison of the size of one object with the size of another. A measurement consists of a numerical value and a unit descriptor. The process of measuring involved several concepts and skills.

Concepts and skills involved in linear measurement:

- **attribute** – the dimension of an object being measured such as length, height, width
- **conservation** – regardless of orientation or movement, the attribute of an object being measured stays the same
- **transitivity** – using a third object to compare lengths of two other objects
- **point of origin/baseline** – the need for a baseline or zero point to begin measuring from and to compare objects
- **direct comparison** – lining two objects side by side to compare their lengths
- **indirect comparison** – comparing two objects that cannot be lined up side by side by using third object to measure with such as a string or ribbon
- **unit** – non-standard units can be either uniform (Unifix cubes, paper clips) or non-uniform (sharpened pencils or hands); standard units are used for consistent communication of measurements – metric and imperial systems; unit sizes and tools allow us to measure with different levels of precision; we use standard units to make communication of measurements clear; different cultures use various types of units to convey measurement information
- **size of unit** – the unit chosen affects the numerical value of the measurement; if you use a larger unit size, fewer units are needed
- **iteration** - units lined up end to end if multiple copies of the unit are available (ie cubes) or iterated if only a single copy is available
- **estimation using a referent** – a referent is used as a comparative quantity

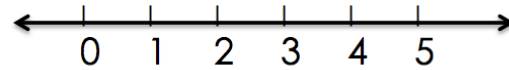
Attributes that are measured by linear measurement are length, height, width, and distance. The distance “around” (perimeter, circumference) a shape or object is also a type of linear measurement.

There is a strong connection between number and measurement. Measurement is essentially assigning a number to an attribute. Models such as number path (counting each spot) and number lines (measurement, counting the distance between marks) highlight this connection.

Number Path



Number Line



Why is it important?

Measurement is one of the main “real-world” applications of mathematics.

There are measurement connections to geometry and spatial reasoning. One way to analyze and describe relationships between geometric shapes is by measuring and comparing their attributes. Shapes and their attributes can be decomposed and composed to aid in their measurement.



There are several developmental continua that have been developed that reflect the general stages of development of an understanding of measurement. The following is how the concept of measurement is developed in three to nine year olds:

1. Children can identify length as an attribute, ie. “That snake is long.”
2. Children can align two objects to compare which one is longer (direct comparison).
3. Children can compare two objects with the length of a third object, such as a ribbon or length of string (indirect comparison).
4. Children can order objects by length (comparing).
5. Children can lay units end-to-end to measure length (may not be consistent with spacing or unit lengths).
6. Children can use a ruler and see the need for standard units.
7. Children understand the importance of unit size in communicating length measurements.
8. Children are fluent measurers – understand importance of standard/identical units, parts of units, origin point/baseline and may begin to estimate.
9. Children are conceptual and visual measurers, using visual referents, visualization (mental movement) and computation to support fluency with measurement conversions.

What to think about?

- Children need practice and exposure to different types of measuring using a range of both mathematically structured and authentic materials from their life experiences.
- Pay particular attention to using mathematically specific language. “Big” is a general term and does not indicate the attribute specifically being measured. Model the use of the terms taller/shorter, longer/shorter, etc.
- Measuring is an opportunity to apply mathematics in authentic tasks such as gardening. Children can measure seed spacing – distance apart and depths to plant seeds. They can measure the perimeter of garden beds or planters to consider how many seeds they can plant. As plants grow they can measure their growth over time and graph this data, comparing this information to projected size information. Students can measure and compare the lengths of stems, leaves, blooms and fruits/vegetables.



What to do?

Provide each student with a length of string or ribbon. Ask them, *How can you use this ribbon to measure?* Students may compare their ribbons to objects in the classroom describing the relationship (longer than, shorter than). Students may iterate the ribbon to measure the length of longer objects. Notice the concepts and processes students are using as they engage in measuring.

What to look for?

Provide or have students choose different items to measure and observe how they measure and what tools they use.

- Are students able to compare items' lengths by direct comparison? Do they line items up along a base line/use a consistent point of origin?
- Are students able to point out or identify the attribute of the item they are measuring? For example, if measuring the length of a book, do they recognize the length as a different attribute than the width or depth?
- Do students use specific mathematical vocabulary to describe measurements? Longer/shorter, taller/shorter rather than bigger/smaller.
- Do students demonstrate an understanding of conservation? If you measure a length of ribbon on a table and then hold it up, do students understand it is still the same length?
- Are students able to make reasonable estimates before measuring? Are they able to use a referent to support their estimates?

What next?

1) If a student is having difficulty measuring, engage in experiences that uncover the students' conceptual understanding of measurement and use of language. If a student continues to use the term "big", model and nudge students to identify what he or she means by big – what attribute is being described. Provide materials such as matryoshka dolls or other nesting toys for students to play with comparing and ordering concepts.



2) If a student is fluent and confident when measuring, challenge students to engage in measurement tasks using visual referents and visualization to measure instead of using measuring materials or tools.

References

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