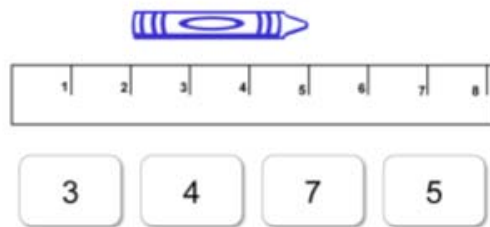


Improving Children’s Understanding of Units of Measure: A Training Study

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Measurement links the abstract world of numbers and the concrete world of physical objects. However, measurement skills lag behind all other mathematics topics for American students (National Center for Education Statistics, 1996). One underlying factor associated with this trend is a lack of understanding of units. Where students have difficulty often involves measuring with a ruler when an object is not aligned with the zero-point. In this case, students simply either read off the number where the object ends or count the number of hash marks between the start and endpoint of the object (Bragg & Outhred, 2004; Ellis, Siegler, & Van Voorhis, 2001; Lehrer et al., 1998), demonstrating an apparent lack of unit understanding.

Example of pre/post-test misaligned item:

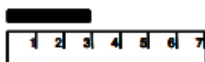


Researchers at the Spatial Intelligence and Learning Center (SILC) at the University of Chicago conducted a training study designed to highlight the importance of units on a ruler. Second grade students were shown how and what needs to be counted (e.g., the *intervals* on the ruler, rather than the numbers themselves) by using discrete units, placed directly on the ruler, when they were measuring items that were not aligned with the zero-point. Objects were then moved back to the start of the ruler and measured again (with units on the ruler) to “check” the answer. Another group of students received a control condition (1), which replicated traditional measurement instruction from mathematics curricula using the same ruler with aligned items *or* units from the training condition but not both together. Another group of students received control condition 2, where unit pieces were placed directly on the ruler but only to measure aligned objects.

Experimental Condition
 (Units combined with aligned and unaligned ruler measurement)



Control Condition 1
 (Traditional Classroom :
 Units and aligned ruler
 measurement shown separately)



Control Condition 2
 (Units combined with aligned
 ruler measurement)



AND



KEY

█ Unit chips

← The arrow symbol shows that a stick is moved to the aligned position after a child measures the stick in the misaligned position

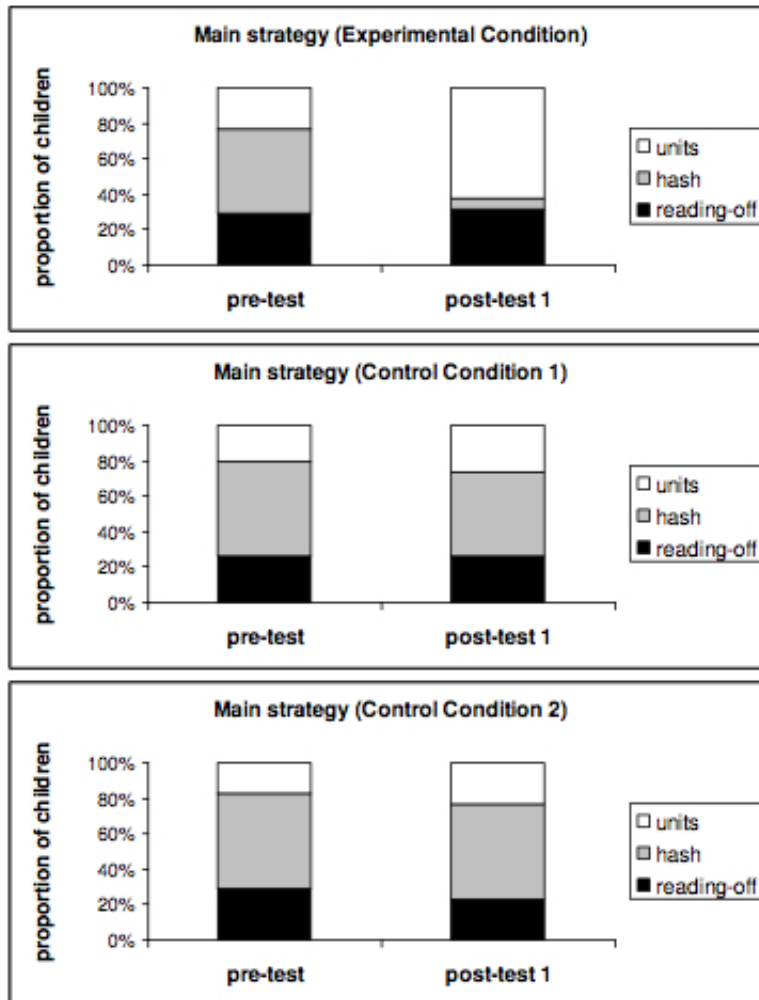


In the training condition shown here (*photo on the right*), the experimenter uses unit pieces to measure an object not aligned with the start of the ruler.

The training group, using the more spatially enhanced method of measurement instruction, showed large improvements in measurement ability compared to the traditional approach to teaching measurement and these gains were maintained one week later.

Strategy differences also related to performance. Children who used the ruler simply as a tool to read off the number where an item ends (regardless of where it starts on the ruler), did not improve after training, whereas the children who counted hash marks showed dramatic improvement. Thus, the training effectively shifted the strategy of students who counted hash mark to counting units.

The combination of measuring misaligned items in conjunction with using discrete objects superimposed on a ruler is an effective method for teaching measurement. Moreover, the more typical instruction used in classrooms (e.g., separate activities of using aligned ruler measurement and measuring with discrete units) is not as effective in promoting the understanding of interval units. Additionally, children who count hash marks on misaligned ruler problems are more prepared to learn about interval units than those who merely read off the rightmost number on the ruler. The training technique is likely more effective because it highlights the fact that units are countable by making each unit extremely salient and has direct implications for instruction in mathematics, whereby emphasizing unit intervals (e.g. using units in conjunction with a ruler to measure misaligned items) can effectively enhance children’s understanding of linear measurement units. Ongoing research is examining whether experience with misaligned then aligned items, as in the training condition, would be effective without the use of discrete units. Additionally, we plan to extend these findings to examine how children measure objects that fall within inch markers (e.g., fractional parts) of both aligned and misaligned objects.



References

Levine, S.C., Kwon, M., Huttenlocher, J., Ratliff, K.R., & Dietz, K. (2009). Children's understanding of ruler measurement and units of measure: A training study. *Proceedings of the 31st Annual Cognitive Science Society*. Amsterdam, The Netherlands: Cognitive Science Society.

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