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Halving and Doubling in Multi-Digit Multiplication: How Students' Spatial Structuring of Arrays Supports Structural Understanding

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This study examined how Year 5 students' spatial structuring of arrays supported their reasoning about halving and doubling in multi-digit multiplication. Arrays are an important representation for developing students' understanding of multiplication because their two-dimensional structure makes visible equal groups, rows and columns, and multiplicative relationships (Battista et al., 1998). While substantial research has examined arrays in relation to the distributive property, existing studies of students' understanding of the associative property have not examined how students' reason about this property through arrays or how arrays might support their understanding of halving and doubling.

The findings suggest that the value of arrays lies not simply in representing multiplication, but in how their spatial structure enables students to act on and reason about multiplicative relationships. In one lesson, students explored the equivalence of 16 × 12 and 24 × 8. By partitioning and rearranging an array into equal parts, students recognised that halving one factor and doubling the other preserved the total number of units and the coordinated row-and-column structure.

In a second lesson, non-examples provided a productive context for exploring the structure underlying the associative property. When comparing 28 × 24 and 26 × 26, some students initially conjectured that taking 2 from 28 and adding it to 24 would preserve the product. Students constructed and compared arrays to test this conjecture and recognised that the transformation did not preserve the multiplicative structure. One student explained that, when halving, "the two parts were the same", whereas simply subtracting from one factor did not produce equal parts. Through these comparisons, students began to distinguish multiplicative from additive compensation, recognising that preserving the product depended on maintaining equal groups and the coordinated structure of the array.

Together, these findings suggest that arrays can provide a powerful basis for developing students' structural understanding of multiplication. Their value lies not simply in making multiplication visible, but in providing a mathematical object that students can transform, compare and interrogate. Students used arrays to test conjectures, identify invariants and justify why particular transformations did or did not preserve the product. Explicitly connecting these strategies to the associative property, alongside opportunities to explore examples and non-examples, supported students in recognising halving and doubling as applications of a general multiplicative property.

References

Battista, M. T., Clements, D., Arnoff, J., Battista, K., & Van Auken Borrow, C. (1998). Students' spatial structuring of 2D arrays of squares. *Journal for Research in Mathematics Education, 29*(5), 503–532.

For more information, please refer to the following paper presented at the 48th Annual Conference of MERGA in July 2026.
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