Exploratory Study of Children's Multi-Digit Multiplication & Division

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BACKGROUND

- There is a dearth of scholarship on either multi-digit multiplication or division, with few studies examining children's reasoning that accompanies strategy use (Fuson, 2003; Harrison, 2013; Hickendorff et al., 2019).
- There is an absence of mixed methods approaches to examining students' responses to sets of tasks, and interview-based analyses.

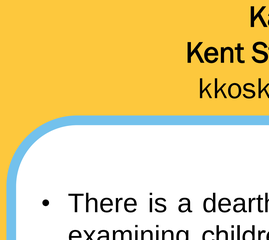
The purpose of this exploratory study is to examine children's strategies & reasonings when solving multi-digit multiplication and division tasks, and associated effects of their exposure to different strategies. This study uses a mixed methods approach to:

Research Timeline

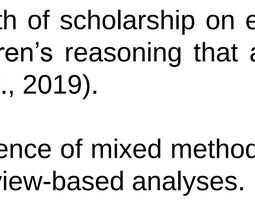
- Year 1 [AY 2024-2025] Focus on Multi-Digit Multiplication
  - Collected written responses from over 1,500 students from over 50 teachers (grades 4, 5, & 6).
  - Sub-sample of 50 eye-tracking enabled interviews.
- Year 2 [AY 2025-2026] Focus on Multi-Digit Division
  - Additional data from participating teachers' classrooms focusing on division.
- Year 3 [AY 2026-2027] Finalize Analysis of Data

Some Strategies Used:

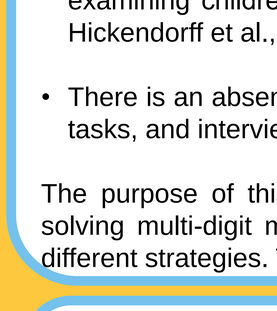
Repeated Addition



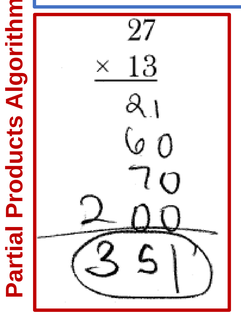
Box



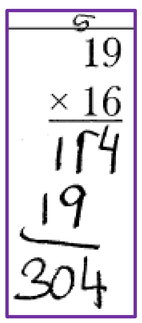
Doubling



Partial Products Algorithm



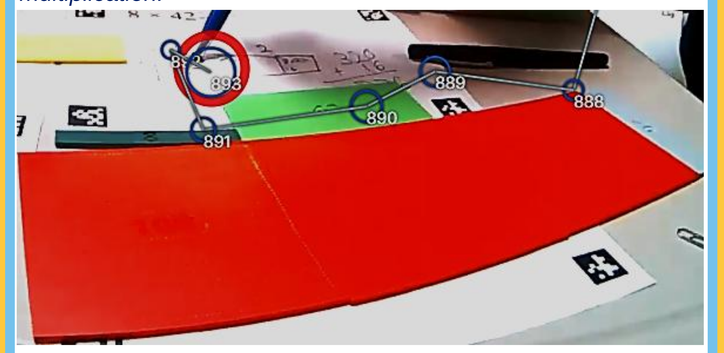
Standard Algorithm



Students' Reasoning

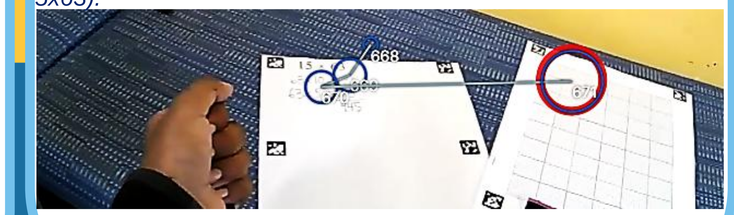
Gr 4 Child anticipating 1 Level of Units

Asked to visually represent 8x42, and relate it to their box model algorithm, the child uses array rods to represent the answer, but can not relate the visual to the process of multiplication.



Gr 4 Child anticipating 2 Levels of Units

Asked to visually represent their partial products algorithm visually for 15x63, this child considers how grid paper can represent each of the two partial products they used (10x63 and 5x63).



Preliminary Results from Grade 4 (*n* = 149)

To Be Presented at PME-NA 2025

% Correct on Task by Algorithm

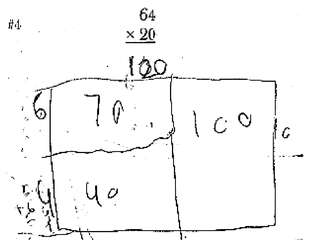
	21×4	19×5	33×8	270×7	4807×8	27×13	19×16	64×20	37×34	86×49
Box	96.7%	96.6%	80.0%	66.7%	65.8%	**70.2%**	**56.9%**	**72.0%**	**59.3%**	**43.4%**
PP	**100.0%**	**97.1%**	**84.4%**	**77.4%**	**66.7%**	48.4%	46.9%	66.7%	46.9%	36.7%
Stand	**89.8%**	**80.7%**	**57.9%**	**57.9%**	**56.1%**	**40.0%**	**32.4%**	**57.9%**	**32.4%**	**25.8%**

% Errors by Algorithm & Task

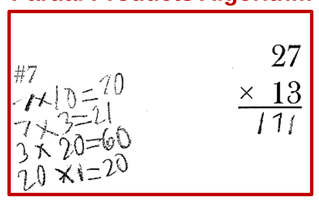
		21×4	19×5	33×8	270×7	4807×8	27×13	19×16	64×20	37×34	86×49
Arith.	Box	-	-	2.9%	6.1%	5.3%	5.3%	15.5%	8.0%	13.0%	16.9%
	PP	-	2.9%	3.1%	6.5%	3.7%	3.2%	3.3%	-	-	10.0%
	Stan	-	-	3.8%	-	2.6%	-	2.9%	-	-	-
Mult.	Box	-	-	2.9%	21.2	18.4%	10.5%	6.9%	8.0%	14.8%	24.5%
	PP	-	-	9.4%	12.9%	14.8%	-	-	12.1%	6.3%	10.0%
	Stan	1.7%	3.5%	3.8%	10.7%	15.4%	-	2.9%	2.4%	2.8%	-
Partitioning Regroup	Box	3.3%	3.4%	14.3%	3.0%	10.5%	10.5%	13.8%	12.0%	13.0%	13.2%
	PP	-	2.9%	3.2%	6.5%	14.8%	48.4%	**54.8%**	21.2%	40.6%	36.7%
	Stan	6.8%	12.3%	18.9%	26.8%	30.0%	48.6%	51.4%	**52.3%**	**51.4%**	**65.6%**

Partial Products Errors Look Different by Algorithm

Box

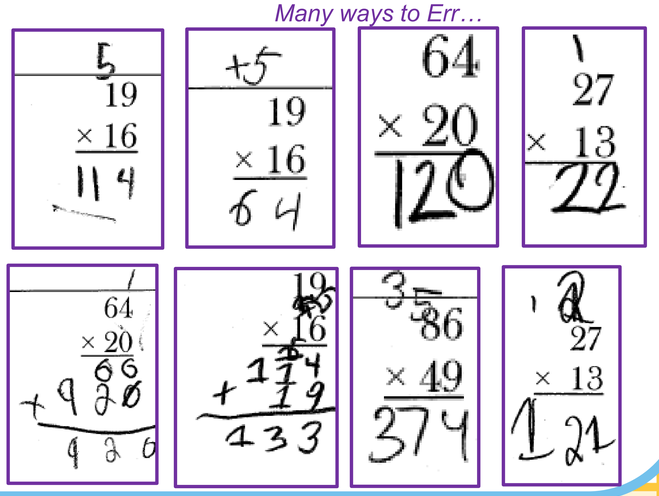


Partial Products Algorithm



Standard Algorithm

Many ways to Err…



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Harrison, D. M. (2013). *A Comparison of Two Prominent Instructional Approaches to the Teaching and Learning of Multi-digit Computation* (Doctoral dissertation).
Hickendorff, M., Torbeyns, J., & Verschaffel, L. (2019). Multi-digit addition, subtraction, multiplication, and division strategies. *International handbook of mathematical learning difficulties: From the laboratory to the classroom*, 543-560. https://doi.org/10.1007/978-3-319-97148-3_33

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