An Early Algebra Intervention's Positive Impact on Students in Grades 3-5

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Introduction & Background

Overview

This is a small-scale longitudinal study on early algebra. We measure the impact of a comprehensive, sustained early algebra intervention in grades 3–5 on students' algebra understanding in elementary grades and their algebra readiness for middle school.

Approximately 150 students from two elementary schools in the same district participated in this quasi-experimental study. Participants in the intervention group were taught approximately 20 early algebra lessons per year across grades 3-5 by a member of our research team. Participants in the comparison group received regular instruction.

Using MANOVA, this poster summarizes the grade 3-5 algebra posttest results comparing the 37 lowest performing intervention students as measured by a standardized general mathematics assessment (NEMA) against the performance of the 38 highest performing NEMA comparison students. Specifically, we compare across the five "big ideas" identified by the early algebra learning progression that provided the curricular framework for the intervention using grade 3 algebra pretest performance as a covariate. We hypothesize that if the algebra intervention has no positive effect for all students, then low-performing NEMA intervention students should have comparable or negative performance on the "big ideas" posttest items juxtaposed against the high-performing NEMA comparison students. Student work examples, educational implications, and future directions are discussed.

ACKNOWLEDGEMENTS

Research funded by the National Science Foundation (NSF #1219606) entitled *Collaborative research: The impact of early algebra on students' algebra-readiness.* Additional support provided by the U.S. Department of Education-IES Research Training Program in the Education Sciences (IES #R305B130007) via the Wisconsin Center for Education Research at the University of Wisconsin-Madison.

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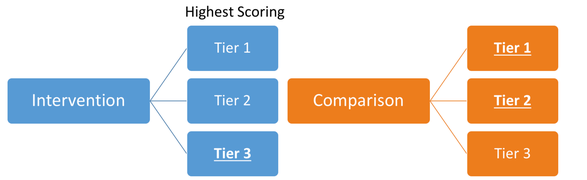
http://algebra.wceruw.org

General Mathematics Performance Groupings
North Eastern Mathematics Assessment



37 Tier 3 Intervention students Vs. 38 combined Tier 1 & 2 Comparison students

Standardized Test Scores

Overall, there are no *North Eastern Mathematics Assessment* performance differences between groups at the end of Grades 3 and 4.

	Grade 3		Grade 4	
	Intervention	Comparison	Intervention	Comparison
Mean	250.4	246.2	243.9	245.5
F-Test	2.72		0.38	
p-value	**.101**		**.539**	

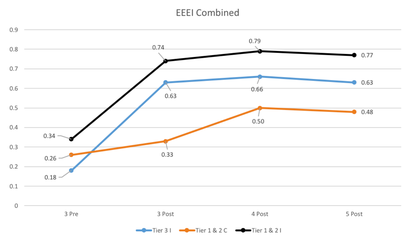
NEMA Instructional Emphasis	% of Battery
Operations & Algebraic Thinking	**25**
Number & Operations in Base Ten	20
Number & Operations-Fractions	20
Geometry	15
Measurement & Data	20

Primary Skill Descriptions and Example Questions

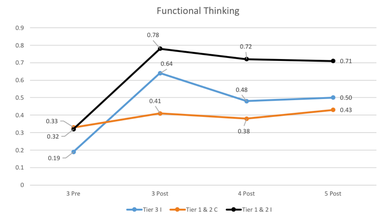
	Skill Description	Items
Skill 1:	**Equality, Expressions, Equations, and Inequalities** Fill in the blank with the value that makes the number sentence true. 7 + 3 = __ + 4. Explain how you got your answer. Find the value of n in the following equation. Show or explain how you got your answer. 10 x n + 2 = 42	1; 2a; 2b; 2c 5a; 5b; 5c1; 5c2; 8
Skill 2:	**Equality, Expressions, Equations, and Inequalities; Variables and Functional Thinking** What is the value of k when p = 61? Show how you got your answer.	10a; 10b; 10c
Skill 3:	**Generalized Arithmetic and Variables** Brian knows that anytime you add any three odd numbers, you will always get an odd number. Explain why this is always true.	3a; 3b; 3c; 4
Skill 4:	**Functional Thinking and Variables** If Brady has 100 desks, how many people can he seat? Show how you got your answer.	9a; 9b; 9c1; 9c2; 9d; 9e1; 9e2; 12
Skill 5:	**Proportional Reasoning** A fourth grade class needs 5 leaves each day to feed its 2 caterpillars. How many leaves would they need each day for 12 caterpillars? Explain…	11

Intervention Tier 3 (received algebra curriculum – **blue line**): Demonstrates **minimal** or **partial** understanding of subject matter and solves some simple problems on *NEMA*. Comparison Tier 1 and 2 (did not receive algebra curriculum – **orange line**): Demonstrates a **comprehensive** or a **solid** understanding of subject matter and provides sophisticated solutions to a wide variety of problems on *NEMA*. Predictor model: $Y_{ij} = \beta_0 + \beta_1(Pretest) + \beta_2(Treatment) + \beta_3(Pretest * Treatment) + \varepsilon$

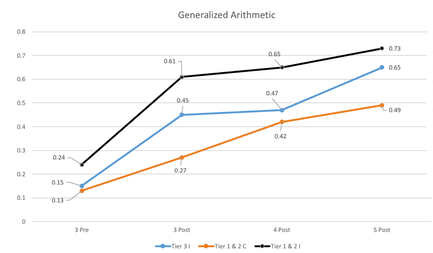
	Posttest Results		
	Grade 3	Grade 4	Grade 5
F-statistic	60.59	11.82	15.29
p-value	.001*	.001*	.001*



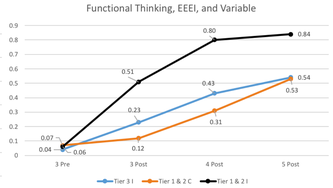
	Posttest Results		
	Grade 3	Grade 4	Grade 5
F-statistic	38.11	7.57	2.39
p-value	.001*	.008*	N.S.



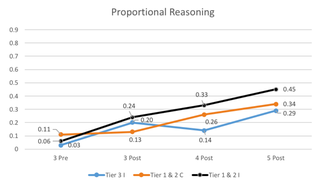
	Posttest Results		
	Grade 3	Grade 4	Grade 5
F-statistic	13.09	0.59	9.19
p-value	.001*	N.S.	.003*



	Posttest Results		
	Grade 3	Grade 4	Grade 5
F-statistic	4.02	1.92	0.01
p-value	.049	N.S.	N.S.



	Posttest Results		
	Grade 3	Grade 4	Grade 5
F-statistic	0.60	1.44	0.28
p-value	N.S.	N.S.	N.S.

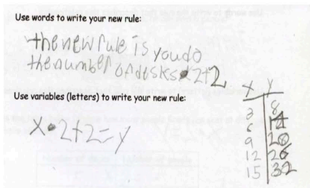


Brady figured out he could seat more people if two people sat on the ends of the row of desks. For example, if Brady had 3 desks, he could seat 8 people.

Original seating arrangement

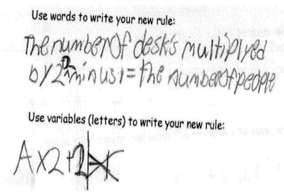
Revised seating arrangement

Grade 4

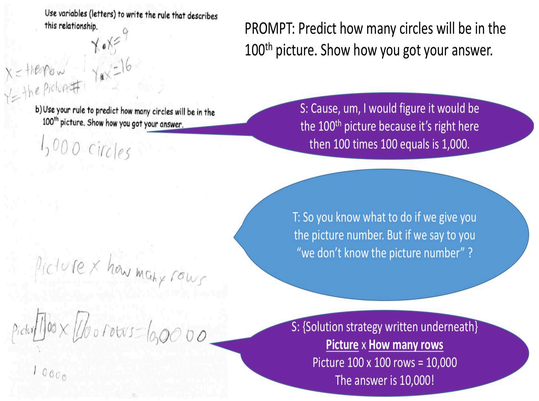


The new rule is you do the number of desks ● 2 + 2.
Using variables: **x ● 2 + 2 = y**

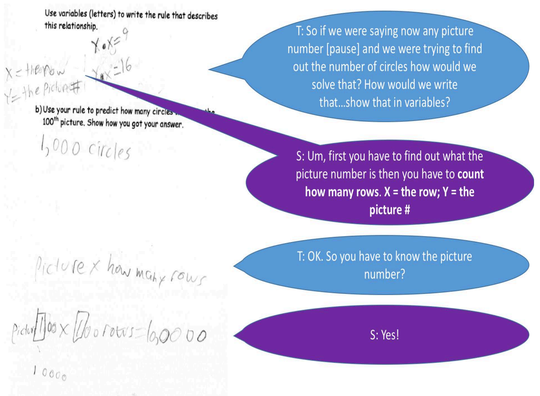
Grade 5



The number of desks multiplied by 2 + 2 minus 1 = the number of people.
Using variables: A x 2 + 2 – 1 then **A x 2 + 2** as final answer.



PROMPT: Predict how many circles will be in the 100th picture. Show how you got your answer.



Discussion:

- ALL students are capable of learning fundamental algebraic concepts and skills
- Emphasize **building and expressing relations** rather than practicing inflexible step-by-step procedures
- The typical elementary math curriculum does little to help students develop an understanding of fundamental algebraic concepts and skills, even for students identified as high achieving.
- It takes time to develop an understanding of algebraic concepts.
- Advocate a longitudinal approach to early algebra instruction

Future Directions: (IES #R305A140092)

- Scaled up the program using 3,500 students from 46 schools across three school districts in one state.
- Intervention students will be taught 20 early algebra lessons per year by their regular classroom teachers
- A subset of teachers will be observed & interviewed to assess fidelity of implementation.
- Monthly PD for teachers providing instruction to intervention students.
- Control students will receive regular instruction.
- Written algebra assessments administered at the beginning of grade 3 and the end of grades 3, 4, 5, and 6.