Reading Skills, Polysemous Word Knowledge, and Executive Functioning in Fourth Grade English Learners' Mathematics Achievement

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Aims

Investigate roles of polysemous word knowledge, reading, and executive function in English Learners' (ELs') & English Speakers' (ESs') math achievement

Background

Reading comprehension (RC) predicts math achievement (MA); RC difficulties (RCD) & math difficulties (MD) cooccur in both ESs & ELs (Abedi & Lord, 2001; Driver & Powell, 2017; Fuchs & Fuchs, 2002; Mancilla-Martinez & Lesaux, 2010; Martiniello, 2008; Pimperton & Nation, 2010; Vilenius-Tuohimaa, Aunola, & Nurmi, 2008)

RCD & MD common sources? (Mann-Koepke & Miller, 2014)

Executive functions (EF) → reading & math achievement (Locascio, Mahone, Eason, & Cutting, 2010; Swanson & Beebe-Frankenberger, 2004)

Polysemous word knowledge (PWK) → reading for ELs & math for all (Logan & Kieffer, 2017; Pierce & Fontaine, 2009; Shaftel, Belton-Kocher, Glasnapp, & Poggio, 2006)

EF predicts PWK (Henderson, Clarke, & Snowling, 2013)

Measures

PARCC Math Scaled Score

PARCC Math Achievement Levels (1-5)

WJ Tests of Achievement (WJTA) word reading

WJTA reading comprehension

WJ Oral Language picture vocabulary Homonym Knowledge (10-items) (Zipke, Ehri, & Cairns, 2009)

Executive Function Composite
- Inhibition (NEPSY)
- Working Memory (TOMAL digits/letters backward)
- Cognitive Flexibility (Cartwright, Marshall, Dandy, & Isaac, 2010)

Participants

201 Urban 4th graders; 58.3% ELs
44.8% Female
84.6% free/reduced meals (FARMS)
62.7% Latino/a; 31.3% Black, 3.5% White, 2.5% other races/ethnicities

Significant Group Differences
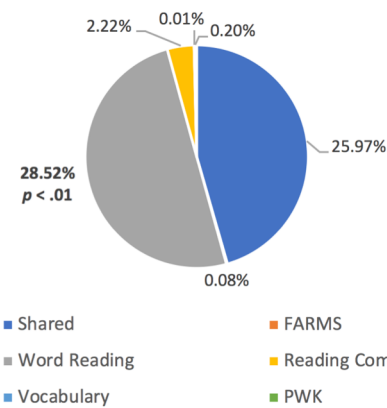(SD in parentheses; * $p < .01$)

	English Speakers	English Learners
PARCC Math Scaled Score	725.64 (33.79)	709.44* (29.65)
PARCC Math Achievement Level	2.60 (1.19)	2.10* (0.93)
Polysemous Word Knowledge	12.44 (3.44)	9.92* (2.69)
WJ Reading Comprehension	28.32 (4.32)	24.41* (4.63)
WJ Word Reading	52.69 (8.30)	48.34* (6.74)
WJ Picture Vocabulary	27.90 (5.09)	23.30* (3.74)

PARCC Math Achievement Differed, ES > EL
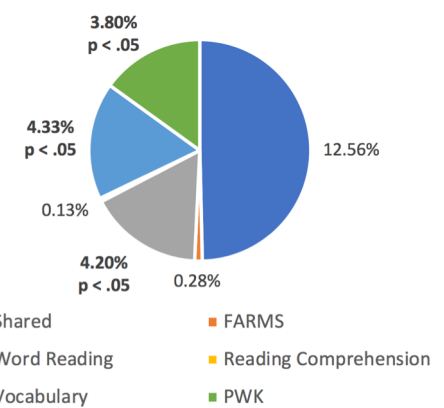(X^2 (4) = 16.17, $p < .01$)

EL PARCC MATH ACHIEVEMENT LEVELS

ES PARCC MATH ACHIEVEMENT LEVELS
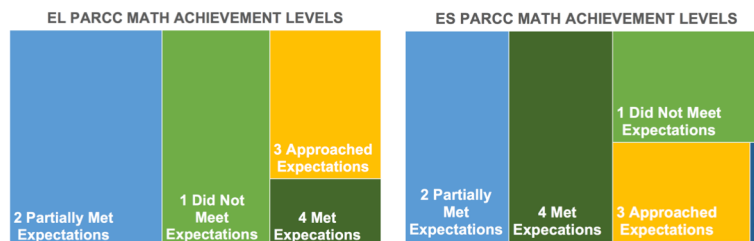
Predicting Math Achievement from PWK, Reading, & Vocabulary

English Speakers (57.00% of variance)

2.22%   0.01%   0.20%
28.52% $p < .01$
0.08%
25.97%

English Learners (25.30% of variance)

3.80% $p < .05$
4.33% $p < .05$
0.13%
4.20% $p < .05$
0.28%
12.56%

■ Shared   ■ FARMS   ■ Word Reading   ■ Reading Comprehension   ■ Vocabulary   ■ PWK

When EF composite was added to regression equations

- EFs captured significant portions of variance for both groups, including PWK contributions
- ES: word reading (25.91%) and EF (12.89%) predicted math achievement (Total 63.4%)
- EL: only EF (17.47%) predicted math achievement (Total 35.0%)

Conclusions

- Reading and EF matter for mathematics achievement

- PWK matters for ELs' mathematics achievement, beyond vocabulary breadth, reading comprehension, & word reading; BUT, only 35% of variance accounted for – what else matters? Computation, strategies?

- A measure of math-specific PWK (i.e., words that have math meanings and common, meanings) would provide a more sensitive predictor of the PWK needed for math (e.g., Logan & Kieffer, 2017, science and social studies PWK)

- EFs shared variance with PWK, consistent with past work (Henderson et al., 2013); this relation should be explored in future work

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