Implementation and Efficacy of Preschool Math Games with Vulnerable Demographic Subgroups

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Introduction

Early Math
Early numeracy is predictive of academic and other outcomes, but many children lack numeracy skills when they enter kindergarten.[1]

Wesleyan Preschool Math Games (WMPG)
Aims to address address the lack of numeracy-oriented curricula in preschool classrooms by providing and testing the efficacy of research-based math games.
Procedure: Pretest, train teachers, implement games, posttest

Play-Based Learning
Guided play is the learning experience that combines structured direct instruction and free play.[2] Math-oriented games are an effective way to promote play-based math learning.[3]

Research question: How can preschools inclusively and universally support math instruction, and to what extent can the Wesleyan Preschool Math Games help do so?

Present Study

Limited research has studied innovative math curriculum in preschool settings with vulnerable subgroups. Thus, it is necessary to identify why vulnerable children are more likely to fall behind in math, and how to implement appropriate curriculum modifications in order to mitigate early risk.

Demographic subgroups of focus:
(1) Children from low-SES backgrounds
(2) Emerging bilinguals and English language learners
(3) Children with special needs
(4) Girls

Study 1. How do vulnerable subgroups of children perform on tests of numeracy skills?
Study 2. How do children from these groups interact with the WPMG curriculum in classrooms?

We used a mixed-methods approach in order to look for presence and size of vulnerability on the numeracy measures, then used qualitative information to understand the nature and nuances of these vulnerabilities in the classroom.

References

1 Duncan et al. (2007) School Readiness and later achievement
2 Weisberg, D.S., Hirsh-Pasek, K., & Golinkoff, R.M. (2013) Guided Play: Where Curricular Goals Meet a Playful Pedagogy
3 Ramani, G. B., & Eason, S. H. (2015). It all adds up: Learning early math through play and games.
4 Purpura, D. J. & Lonigan, C. J. (2015). Early Numeracy Assessment: The Development of the Preschool Early Numeracy Scales.
5 Wynn, K. (1990). Children's understanding of counting.

Study 1

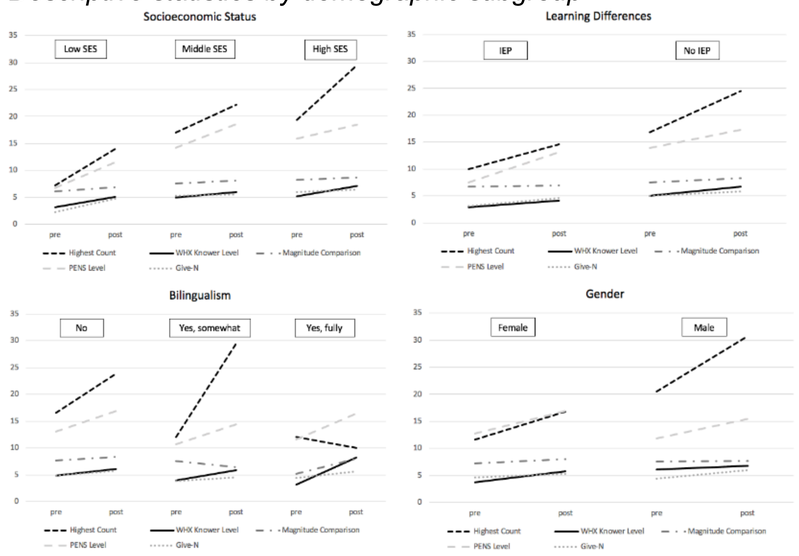
Methods

Participants: 59 children from 9 diverse public and private preschools in Connecticut (18 classrooms)
- Demographic forms collected from caregivers

Measures:
Highest Count PENS [4] Give-A-Number [5]
Which-has-x Magnitude Comparison

Results

Descriptive statistics by demographic subgroup



Partial correlations between pre-test performance on assessments and demographic variables, controlled for age at baseline.

Measure	SES_ composite	Disability_ code	Bilingual_ code	Gender_ code
Pretest				
Highest Count	-0.242	-0.109	-0.083	-0.358**
WHX Knower Level	-0.159	-0.144	-0.130	-0.519**
Magnitude Comparison	-0.128	0.021	-0.300*	-0.296*
PENS Level	-0.354**	-0.256†	-0.049	-0.178
Give-N	-0.437**	-0.231	-0.108	-0.161

† p < .08 * p < .05 ** p < .01

Discussion

1. Low-SES, learner differences, and bilingualism presented lower assessment scores than their counterpart peers at baseline. These gaps persisted in posttest.
2. Gender produced mixed results by assessment

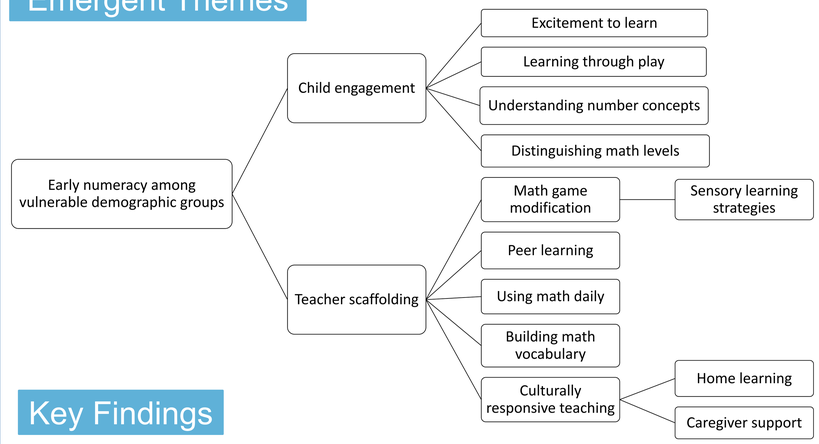
Study 2

FOCUS GROUP

Methods

Participants: N = 4 teachers; all female, 3 schools
Procedure: Semi-structured interview using Zoom → Grounded theory thematic coding analysis

Emergent Themes



Key Findings

Child engagement	Teacher scaffolding
• WMPG are supportive of play, fun learning, effective math instruction • WMPG are adaptable by skill level & foster guided play	• Teaching is not easy • Instructional modifications for supporting math learning • Culture & families impact learning

OBSERVATIONS

Methods

Participants: N = 4 classrooms; 3 schools, public & private
Procedure: Overt naturalistic participant observations (1.5-2 hours) → Grounded theory ethnographic coding

Emergent Themes

Math play and game engagement
1) challenges of math games
2) learning through play
3) understanding math concepts
4) attention spans

Teacher strategies
1) one-on-one scaffolding
2) specific probe language
3) student engagement when teacher was present
4) use of visual aids
5) student grouping

Key Findings

Low-SES: Poor classroom quality, limited math, teacher role
Learner Difference: Spectrum of math abilities, inclusive games
ELL: Threat of isolation, limited language, engaged in games
Gender: teacher bias, gendered social behavior & play style

General Discussion

- Children learn more when an adult guide is present to help scaffold explorative mathematical experiences
- Play-based numerical games provide rich math experiences for students
- WMPG are adaptable and inclusive → support overall development
- Child's environment (inside and outside) contributes to educational risk factors

Limitations

1. Not all students can be tested
2. Small sample size
3. Low response rate

Next Steps

1. Facilitate community of teachers to share ideas
2. Support community building