A Study of the Impact of an Early Childhood Intervention on STEM Learning

The University of Toledo
Charlene Czerniak, Joan Kaderavek,
Peter Paprzycki, Scott Molitor, Susanna Hapgood,
Jeanna Heuring, and Grant Wilson

NARST
A global organization for improving science education through research

March 2020

Nurtures

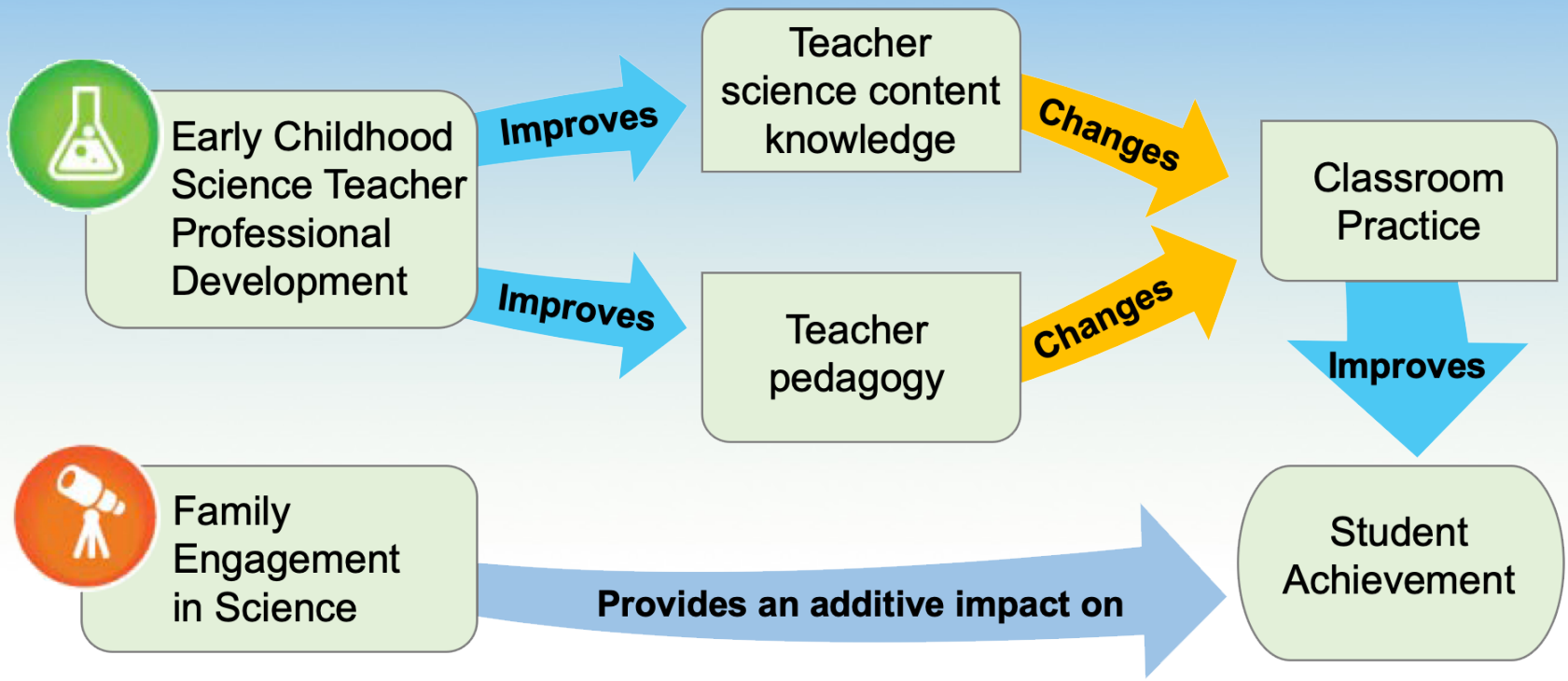
JUDITH HERB COLLEGE OF EDUCATION
COLLEGE OF ENGINEERING
THE UNIVERSITY OF TOLEDO

Supported by
National Science Foundation
DRK-12 Grant #1721059

NURTURES Program

Nurtures

Theory of Action



Nurtures

NURTURES Program

NURTURES Phase I: 2011-2017

- Notable research findings:
  - Improved student achievement in math, early literacy, reading
  - Longitudinal effects in math, reading, and science

NURTURES Phase II: 2017-2020

- Research Aims:
  - Student achievement across three samples groups: Control, PD & PD + Family Engagement

Phase I: NSF #1102808 | Phase II: NSF #1721059

Nurtures

Study Focus

- Investigate whether exposure to NURTURES-trained teachers affected student learning outcomes for ***PreK-K*** in science, mathematics, early literacy, and reading.

- Determine if children whose families participated in family engagement STEM provided an additive positive impact on child outcomes.

Family Engagement in STEM Learning During Early Childhood

Need for family engagement:

- Children spend less than 20% of their day in school
- Families focus on reading and math vs. science and engineering
- Parental factors – low interest, anxiety, and confidence

Strategies for family science engagement:

- Community-based – informal science learning venues
- School-based – family engagement kits
- Home-based – family engagement packs

Nurtures

State of EC STEM Assessment

STEM assessment of very young children poses challenges:

- Aligned with curriculum
- Authentic tasks or observation of abilities - in real time
- Developmentally appropriate-not paper and pencil
- Easily incorporated into ongoing evaluation procedures

Current science assessment tools:

- Science Learning Assessment (SLA-Purdue)
- Woodcock-Johnson-III Science Knowledge Subscale (WJ-III-HMHCO)
- Preschool Science Assessment (PSA-U Miami)
- Early Learning Scale (ELS/KELS-NIEER)

Nurtures

Methods

Program

Professional Development

- Summer Institute & AY PLCs

Family Engagement Resources (randomized group)

- Family Packs
- Family Engagement Events

Early Learning Scale Instrument

- Rubric scoring on select items focused on math, science, language & literacy
- Teachers collected Fall & Spring data

Early Learning Scale Training

- Web-based training on scope and application
- Aim to Integrate with existing assessment protocols

Nurtures

Study Participants

Selection:

- RCT research design
- PreK-K programs from sixteen rural Midwestern schools
- Participants active in program for 1 year
- Male/Female students evenly distributed

Instrument

Domain: Math/Science

- Item 1: Number and Numerical Operations
- Item 2: Classification and Algebraic Thinking
- Item 3: Geometry and Measurement
- Item 4: Scientific Inquiry

Domain: Language and Literacy

- Item 7: Oral Language
- Item 8: Phonological Awareness
- Item 9: Print Awareness
- Item 10: Writing

NATIONAL INSTITUTE FOR EARLY EDUCATION RESEARCH
NIEER

Instrument Scoring

Examination and Reconsideration of Prescribed Scoring Procedures

SCORING PROCEDURES AND GUIDELINES

Procedures

For further information on the ELS/KELS instrument visit:
www.myelsonline.com

ELS
EARLY LEARNING SCALE

Instrumentation: PreK

Items	Number of Items	Labels		
Domain: Math/Science				
Item 1: Numbers and numerical operations	3	01 = Num.1	02 = Num.2	03 = Num.3
Item 2: Classification and algebraic thinking	2	04 = Class.1	05 = Class.2	
Item 3: Geometry and measurement	2	06 = Geom.1	07 = Geom.2	
Item 4: Scientific inquiry	3	08 = SI.1	09 = SI.2	10 = SI.3
Domain: Language and Literacy				
Item 7: Oral language	2	11 = OLAN.1	12 = OLAN.2	
Item 8: Phonological awareness	1	13 = Phon		
Item 9: Print awareness	2	14 = Read.1	15 = Read.2	
Item 10: Writing	2	16 = Write.1	17 = Write.2	
Total	17			

Measurement Model: PreK and K

Recommended scoring model did not work well.

- Used Polytomous Rasch Rating Scale Model (RSM) (Andrich, 1978a, 1978b) as implemented in Winsteps (Linacre 2009) software to evaluate all items

- Rating Scale utilized three observable scores for all items:
  - "1" (observed) = "1" (recoded)
  - "3" (observed) = "2" (recoded)
  - "5" (observed) = "3" (recoded)

- Fall 2018 anchored items measures were used to calibrate Spring 2019 items measures (Fall 2018 frame-of-reference)

- Obtained scale-free calibrations of all items (not just strands) difficulty levels and children's ability measures

Nurtures

Demographics: PreK

Characteristic	Fall 2018		Spring 2019	
	n	%	*n*	%
Intervention				
Control	136	40	129	41
PD	83	24	77	24
PD+	120	35	111	35
Gender				
Female	161	47	147	46
Male	175	52	167	53
Missing	3	1	3	1

Linear Regression Results: PreK

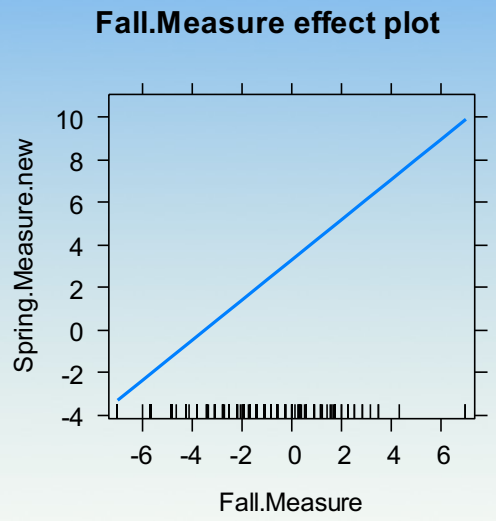
Variable	*B*	*SE B*	*t*	*p*
Intercept, B_0	2.73	0.25	11.12	< .001
Falll measure, B_1	0.94	0.05	20.66	< .001
Gender, B_2	0.02	0.23	0.07	.941
Intervention, $B_{3\ (PD)}$	0.96	0.30	3.22	.001
Intervention, $B_{4\ (PD+}$	0.79	0.27	2.92	.004

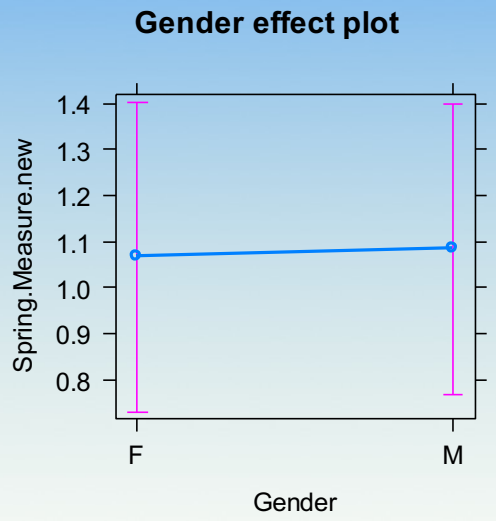
Regression approach was used:

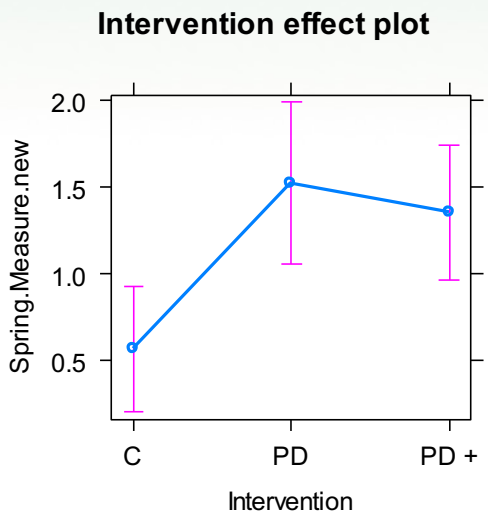
- Spring 2019 – outcome variable
- Fall 2018 – covariate
- Gender – factor (controlling variable)
- Intervention - factor

Nurtures

Results Marginal Effects: PreK







Nurtures

Demographics: K

Characteristic	Fall 2018		Spring 2019	
	n	%	*n*	%
Intervention				
Control	46	49	45	52
PD	30	32	24	28
PD+	18	19	18	21
Gender				
Female	46	49	41	47
Male	48	51	46	53

Instrumentation: K

Items	Number of Items	Labels		
Domain: Math/Science				
Item 1: numbers and numerical operations	3	01 = Num.1	02 = Num.2	03 = Num.3
Item 2: classification and algebraic thinking	2	04 = Class.1	05 = Class.2	
Item 3: geometry and measurement	2	06 = Geom.1	07 = Geom.2	
Item 4: scientific inquiry	3	08 = SI.1	09 = SI.2	10 = SI.3
Domain: Language and Literacy				
Item 7: oral language	2	11 = OLAN.1	12 = OLAN.2	
Item 8: phonological awareness	1	13 = Phon		
Item 9: reading	3	14 = Read.1	15 = Read.2	16 = Read.2
Item 10: writing	2	17 = Write.1	18 = Write.2	
Total	18			

Linear Regression Results: K

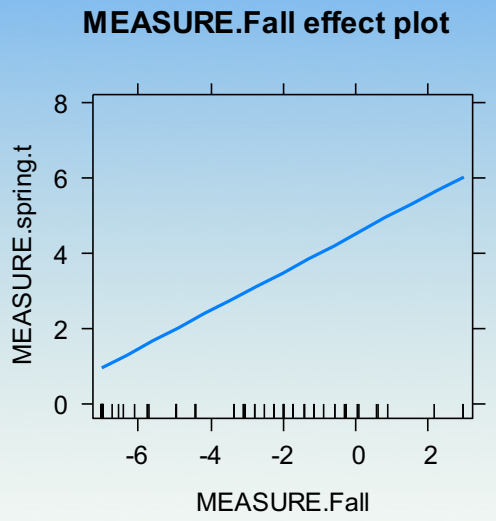
Variable	*B*	*SE B*	*t*	*p*
Intercept, B_0	3.74	0.66	5.69	< .001
Falll measure, B_1	0.51	0.14	3.66	< .001
Gender, B_2	-0.10	0.71	-0.14	.887
Intervention, B_3 (PD)	0.98	0.86	1.14	.258
Intervention, B_4 (PD+)	2.46	0.98	2.52	.014

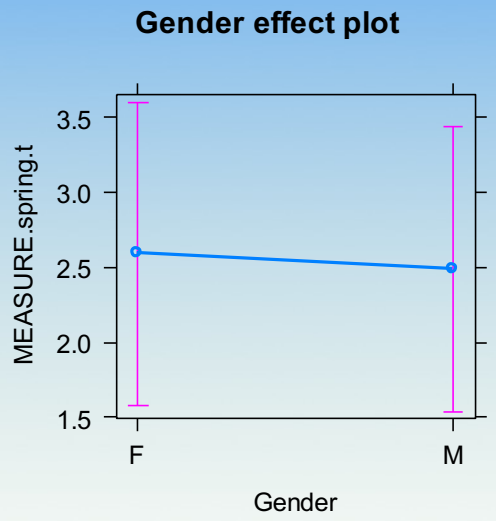
Regression approach was used:

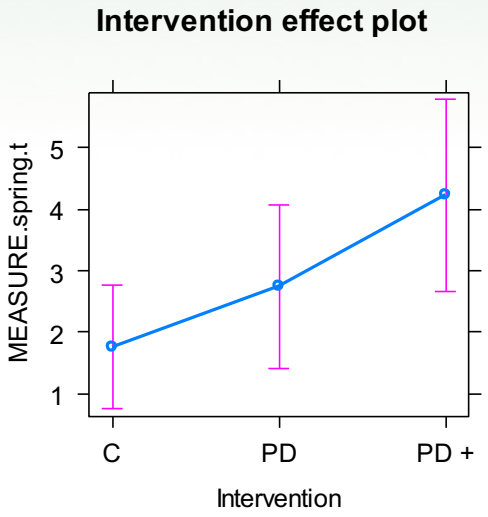
- Spring 2019 – outcome variable
- Fall 2018 – covariate
- Gender – factor (controlling variable)
- Intervention - factor

Nurtures

Results Marginal Effects: K







Nurtures

Conclusions & Implications

✓NURTURES programming shows a positive impact on PreK-K student achievement.

✓Preliminary findings indicate the usefulness of the ELS/KELS instrument for EC STEM assessment.

▸ Further research will involve gathering data on student achievement, fidelity of implementation with family engagement components, and inter-rater reliability.

Questions & Contact Info

For further information on NURTURES visit:

nurtures.utoledo.edu

or email: nurtures@utoledo.edu

For further information on the ELS/KELS instrument visit: www.myelsonline.com