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

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NARST
A global organization for improving
science education through research

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JUDITH HERB COLLEGE OF EDUCATION
COLLEGE OF ENGINEERING

THE UNIVERSITY OF TOLEDO

NURTURES Program

Theory of Action
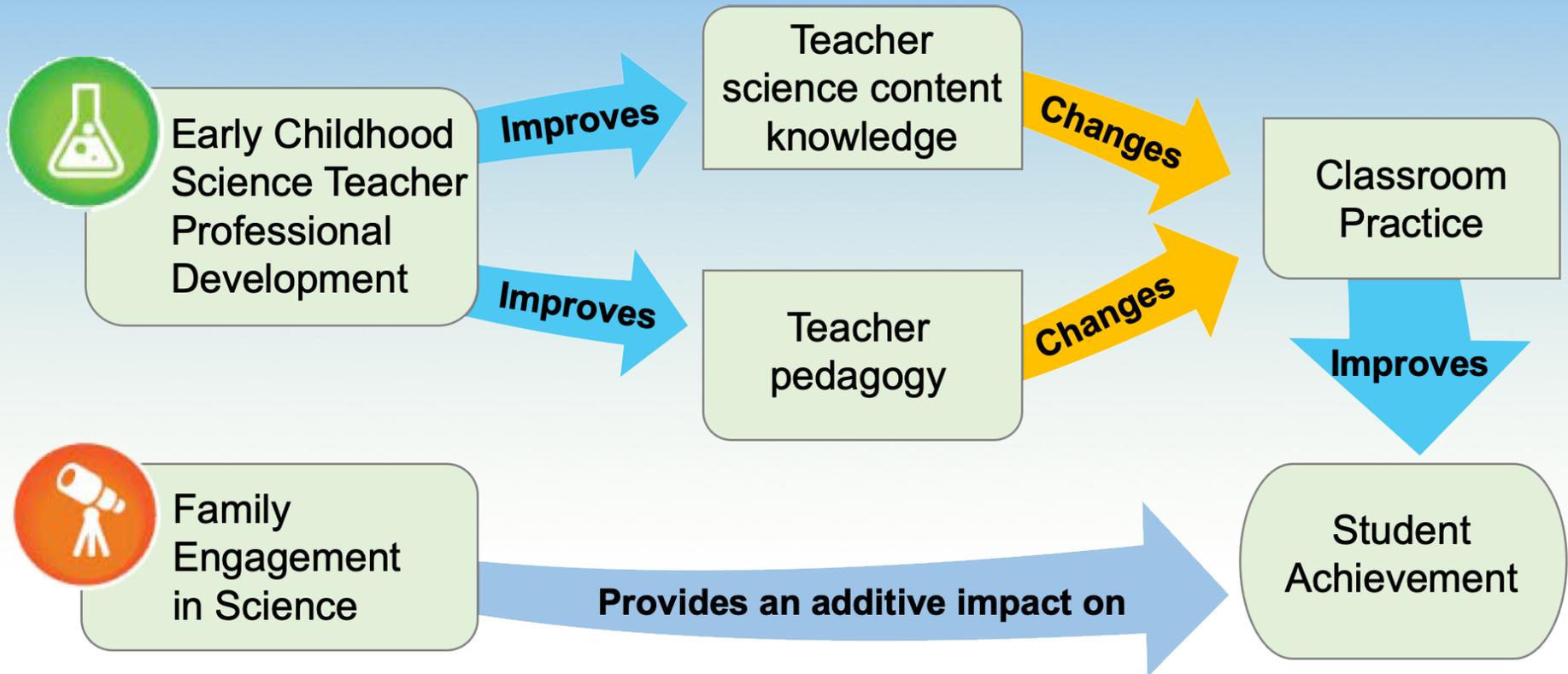
NURTURES Program

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

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

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)

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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

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

ELS — EARLY LEARNING SCALE

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

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DOMAIN

Language and Literacy

7 — Oral Language

	1	2	3	4	5
Speaking	• Uses gestures to communicate • Unlikely to participate in discussions • May use very short phrases		• Responds using simple sentences • Responds to low-level questions		• Uses complex sentences and strong vocabulary • Participates in discussions by asking questions and making connections
Story Retelling	• Retells familiar stories using pictures, but with little connection to the actual story line		• Retells familiar stories with some main components, but may differ from story line		• Retells familiar stories with some accuracy and details

8 — Phonological Awareness

	1	2	3	4	5
Language Manipulation	• Responds to rhymes and music • Repeats parts of rhymes and chants		• Recites chants and rhymes • Repeats language with repetitive beginning sounds (alliteration)		• Separates words into syllables • Creates own rhymes and/or alliteration

9 — Print Awareness

	1	2	3	4	5
Alphabetic Awareness	• Identifies few letters, if any		• Identifies some letters		• Identifies many letters and may comment about letters in the environment • Recognizes that letters form words
...nowledge	• Does not recognize that print carries meaning • Recognizes prominent and common print in environment by relying on picture cues		• Recognizes that print has meaning • Recognizes some print in the classroom, including his or her own name		• Understands that print is used for different functions • Identifies print in environment, such as classmates' names, signs, and/or symbols

10 — Writing

	1	2	3	4	5
Composing	• May identify scribbling as "writing" • Does not give meaning to writing		• Verbally labels own "writing" or drawing • Provides dictation to an adult to be written on a piece of work		• Writes symbols for a purpose—to convey information or tell a story
Production	• Draws or scribbles				• Strings conventional letters together (other than his or her own name)

ITEM

INDICATORS

STRAND

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

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

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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

Results Marginal Effects: PreK
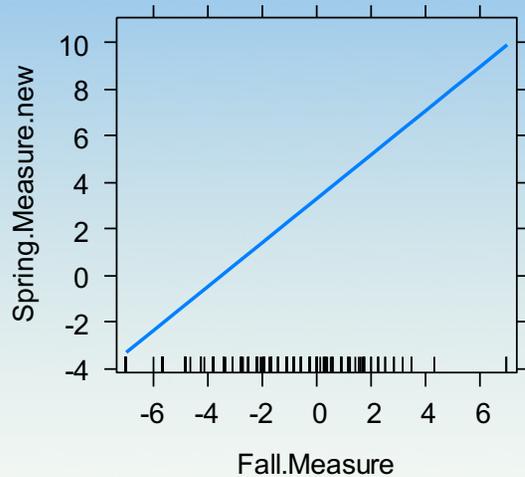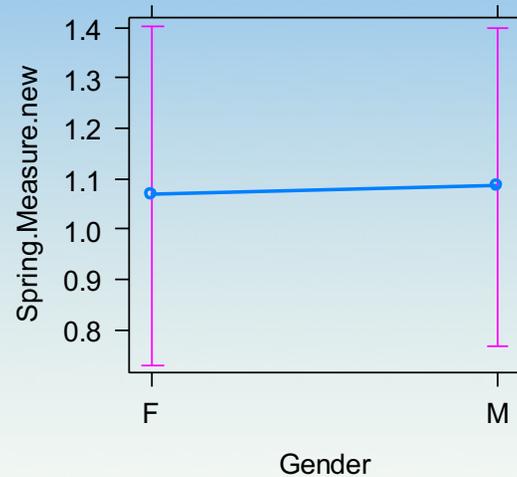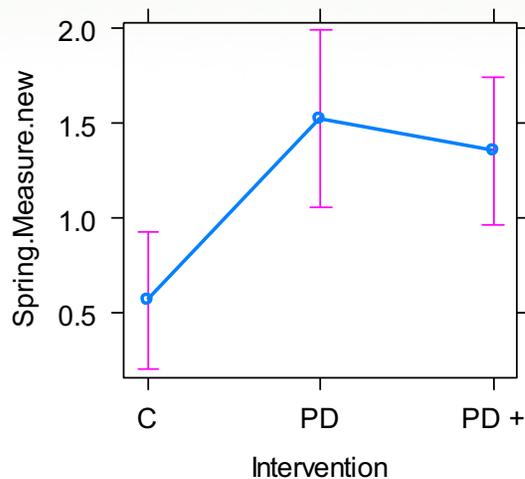
Demographics: K

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		
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Item 1: numbers and numerical operations	3	01 = Num.1	02 = Num.2	03 = Num.3
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Item 10: writing	2	17 = Write.1	18 = Write.2	
Total	18			

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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

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- Fall 2018 – covariate
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- Intervention - factor

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# Results Marginal Effects: K
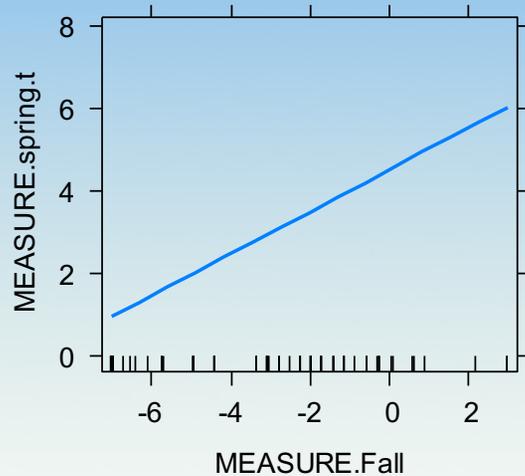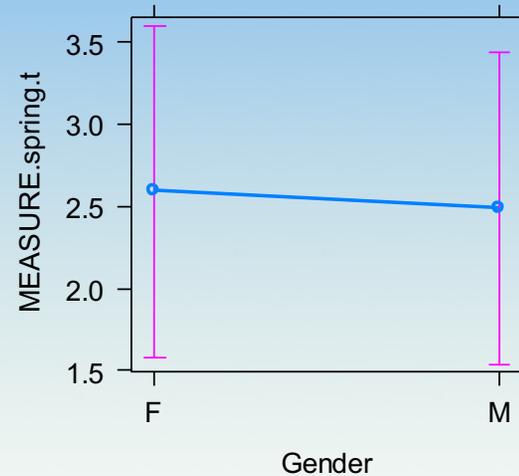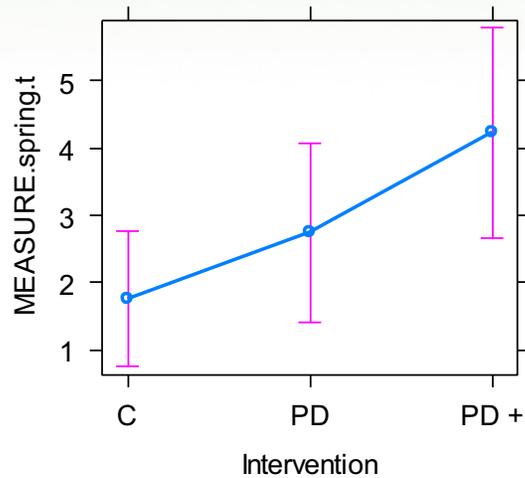
Conclusions & Implications

✓ 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

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nurtures.utoledo.edu

or email: nurtures@utoledo.edu

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