Developing and Validating a Measure of Parental Knowledge About Early Math Development

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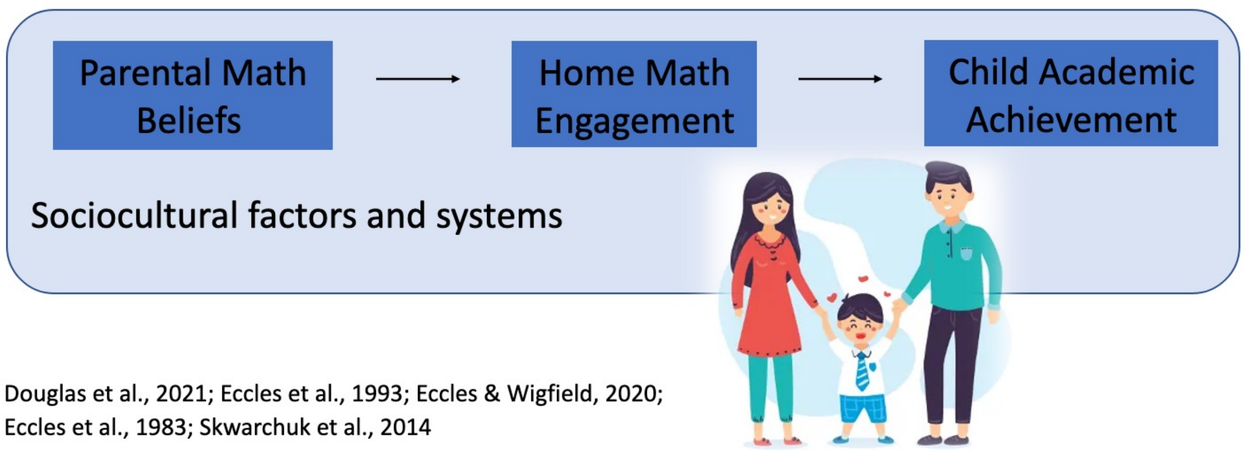
INTRODUCTION

- The math support that parents provide their young children at home is predictive of their children's later math skills (Mutaf-Yıldız et al., 2020)

Situated Expectancy Value Theory (SEVT)



Douglas et al., 2021; Eccles et al., 1993; Eccles & Wigfield, 2020; Eccles et al., 1983; Skwarchuk et al., 2014

- Parents' knowledge about infant development is theorized to shape their beliefs and support for their children's development, including their home literacy environment (Bornstein et al., 2010; Sonnenschein & Sun, 2017).
- A few studies have examined the nature of parents' knowledge about early math development:
  - Most UK Mothers of 3- to 4-year-olds incorrectly anticipate children understand cardinality regardless of age or counting ability (Fluck et al., 2005)
  - Canadian parents of 3- to 5-year-olds mark almost all activities on a list as important or essential to early math development (Skwarchuk, 2009)
  - US parents with middle SES have more accurate knowledge of which math skills a typical 5-year-olds can develop compared to parents with low SES (Deflorio & Beliakoff, 2015).
  - However, these studies used different measures and did not report any psychometric properties, reliable and valid measures of parents' knowledge are needed.

METHOD

- Closed-ended, self-report measure of parents' knowledge about early math development
- Iteratively revised and administered electronically online (Study 1, 3-5) and in person (Study 2)

Participants 616 U.S. parents of 3- to 5-year-olds across five studies in 2021 and 2022. Parents were recruited via CloudResearch except for Study 2 in which parents were recruited via a university department database.

Measure "Which of these academic skills are appropriate to work on with typically developing 4-year-old children in the United States. (Please select "Yes" for each skill that you think is appropriate. Otherwise select "No").

- 10 numeracy – 7 within the developmental range, 3 beyond
- 10 patterning – 7 within the developmental range, 3 beyond
- 10 distractor spatial items
- For Study 4 and 5, we added two additional pattern within items for a total of 32 items

RESULTS

Knowledge Measure Means Across Studies

	Study 1 (N = 161)	Study 2 Time 1 (N=34)	Study 2 Time 2 (N=21)	Study 3 (N = 45)	Study 4 (N = 45)	Study 5 (N = 344)
Numeracy Within	.82	.88	.85	.85	.80	.79
Pattern Within	.78	.81	.84	.80	.80	.74

[a]Study 4 and 5 included two additional patterning within items
[b]Study 5's excludes two items (cardinality and abstraction)

Reliability Evidence from Study 5

Numeracy Within (n = 7): α = .59 and KR20 = .60;
Patterning Within (n = 9): α = .65 and KR20 = .66
2 items, 1 numeracy & 1 patterning, were excluded for low ICC

Validity Evidence from Study 5

Construct: Confirmatory Factory Analysis indicated each item fit well to our constructs shown by items significant factor loading onto our pattern or numeracy factor respectively. Models also fit the data well for a two-factor correlated model according to several indices (e.g. nonsignificant χ^2, CFI > .9, and RMSEA < .08)

Convergent: Parents' early math knowledge & perceptions of child's math abilities were significantly correlated: r(342) = .11, p = .036 (numeracy) & r(342) = .24, p < .001 (patterning)

Discriminant: Parents' early math knowledge & perceptions of child's literacy abilities were not significantly correlated: r(343) = .05, p = .342 (numeracy) & r(343) = .09, p = .112 (patterning)

Parents' Knowledge about Early Math Development Within the Developmental Range

Numeracy Subscale	Study 1 (N = 161) Mean	Study 1 (N = 161) Factor Loading[a]	Study 5 (N = 344) Mean	Study 5 (N = 344) Factor Loading[a]
Count a row of 15 objects (for example, count 15 plastic worms) [a]	.96	.29	.94	-
Counts out the correct number of things when asked for a specific number of things up to 10 (for example gives 6 cookies when asked for 6 cookies)	.81	.68	.89	.39
Name the written numbers from 1 to 10 (for example, points to the 9 when asked "where is the number nine?"	.87	.48	.86	.50
Solve small addition or subtraction problems presented with objects (for example, 3 blocks and 2 blocks is ___ blocks)	.73	.51	.82	.30
Tell which of two spoken numbers between one and ten is bigger (for example, says "five" in response to "Which is bigger, five or two?"	.86	.51	.76	.58
Tell which of two written numbers between one and ten is bigger (for example, points to the written number 9 when shown the written numbers 2 and 9 and asked "Which is bigger")	.86	.52	.76	.54
Answer questions by adding or subtracting small numbers (for example, says "three" in response to "If you have four stickers and then you give me one of your stickers, how many stickers would you have left?")	.65	.44	.68	.35
Pattern Subscale	**Study 1 (N = 161) Mean**	**Study 1 (N = 161) Factor Loading[a]**	**Study 5 (N = 344) Mean**	**Study 5 (N = 344) Factor Loading[a]**
Use colored beads to make a simple pattern, such as a "blue-purple" pattern	.88	.37	.78	.34
Figure out what should come next in a simple pattern (for example: clap, stomp, clap, stomp, _, _)	.85	.34	.72	.45
Sort a set of objects into 2 groups based on color such as red and blue	.91	.19	.91	-
Identify two patterns that follow the same rule made with different materials (for example, a block-block-ball pattern and a sun-sun-moon pattern are similar)	.65	.29	.60	.45
Fill in the missing part of a pattern made of repeating objects (for example: circle, square, square, circle, square, __, circle, square, square)	.76	.66	.63	.61
Make the same kind of simple pattern in their bracelet as their friends' bracelet, but using different colors (for example, your child makes a yellow-green pattern to match a friend's red-blue pattern)	.60	.24	.65	.38
Makes a repeating pattern (for example, makes a clap, spin, snap, clap, spin, snap pattern)	NA	NA	.74	.50
Copy a pattern someone else makes in the same way (for example, your child beats a drum in a loud-soft pattern just like do)	NA	NA	.80	.33

Notes. [a]Factor loadings are standardized.
NA indicates the item was not included in this iteration of the measure

CONCLUSION

- First paper to iteratively revise and develop a measure of parents' knowledge of early math development
- Final version of the knowledge measure (Study 5) demonstrates strong evidence for construct, convergent, and discriminant validity and some evidence of reliability for the numeracy and patterning subscales.

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