

Developing a rigorous measure of the Preschool Home Maths Environment (PHMQ)

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Background

Children's initial variation in early mathematics suggests that experiences outside of the school setting, namely the home environment, may support learning and development. This study systematically developed a comprehensive home maths environment questionnaire that reliably assesses the experiences of pre-school children (i.e. 3-5-year-olds) following recent recognised scale development and validation methods. Four studies were used to develop and validate the Pre-school Home Maths Questionnaire (PHMQ).

Study 1: Item generation

This study focused on the creation of items that assess the construct of the home maths environment. Parents (N = 8) were interviewed and has children aged 37 months to 59 months, $M_{age} = 47.5$ months. Initial item generation; 44 inductive and 25 deductive items. 8 home environment dimensions within the Pre-school Home Maths Questionnaire (PHMQ); 1) Parent expectations, 2) Child maths literacy, 3) Counting ability, 4) Parent-child teaching methods, 5) Target child-sibling interactions, 6) Frequency of numeracy activities scale, 7) Child's understanding of numeracy and 8) Support question.

Study 2: Questionnaire refinement

Questionnaire administration to parents/guardians (N = 172). Parents/guardians had children aged 36 months to 60 months, $M_{age} = 46.2$ months. New questionnaire was refined through exploratory factor analysis addressing construct validity (i.e. factor structure and scale score reliability). See Table 1.

Study 3: Scale validation (qualitative)

Assessed content (considers whether appropriate questions have been asked in the PHMQ) and criterion (investigates contrast cases of parents with very high or very low scores on each of the themes within a questionnaire and compares the contrasting cases to the interview responses) validity of the frequency of numeracy activities scale through parent interviews (N = 8). Parents/guardians had children 36 months to 49 months, $M_{age} = 42.8$ months.

Study 4: Scale validation (quantitative)

Focused on construct validity through confirmatory factor analysis of the frequency of numeracy activities scale. Questionnaire administration (N = 136). Parents/guardians had children 43 months to 54 months, $M_{age} = 48$ months.

Conclusion

Overall, the four studies demonstrate construct, content, and criterion validity. Hence, the new PHMQ measure satisfies APA standards for psychometric adequacy.

Table 1. Summary of confirmatory factor analysis results for home numeracy environment questionnaire (N=172)

Items	Factor loading	Eigenvalues	% of variance	α
(1) Parent-child interaction		7.16	25.58	.81
Identifying names of written numbers	.65			
Write numbers	.59			
Teaching about measurements (e.g. baking or height)	.54			
Time terminology (e.g. big hand, little hand)	.50			
Asking shape related questions (e.g. "how many sides does a circle have?")	.49			
Scenarios number games (e.g. "if I have two toy cars and I take one away, how many cars do I have?")	.49			
Teaching about money (e.g. playing shop or buying sweets)	.43			
Sticker books	.38			
(2) Computer maths games		2.39	8.52	.81
Maths related websites (e.g. coolmaths.com)	.71			
Racing games (e.g. the faster they complete sums, the faster the boat moves)	.67			
Size/matching apps (e.g. "put the big skirt on the small girl")	.65			
Maths applications (e.g. Number Jacks)	.63			
Add and subtraction games	.60			
Filling in the gap number games (e.g. what is next in the sequence?)	.51			
(3) TV programmes		2.14	7.63	.79
Watching number related TV shows (e.g. Number Jacks or Numtums)	.89			
Rhyming TV shows involving numbers (e.g. Number Jacks)	.85			
Watch educational programs (e.g. Dora the Explorer)	.38			
(4) Shape		1.67	5.95	.78
Sorting shapes	.62			
Sorting objects by size	.61			
Creating patterns with objects (e.g. arranging blocks into shapes)	.61			
Playing with building blocks	.58			
Play with jigsaws	.54			
Pairing/matching games	.44			
(5) Counting		1.53	5.45	.76
Counting out food, dinner plates, knives and forks	-.61			
Counting	-.59			
Counting objects (e.g. ducks in bath, blocks, new toys, books)	-.55			
Counting on fingers/hands	-.55			
Comparing sets of objects (e.g. brother has more than mum)	-.52			

Parents were asked, "In the past month, how often did you and your child engage in the following?" Response options included: activity did not occur (0), few times a month (1), about once a month (2), few times a week (3), and almost daily (4).