

# Adaptation and Validation of the Home Numeracy Environment Questionnaire in an Argentine Population

## *Adaptación y Validación del Cuestionario sobre el Entorno Numérico en el Hogar en Población Argentina*

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### ABSTRACT

The Home Numeracy Environment (HNE) plays a critical role in children's early mathematical development. Nevertheless, culturally adapted instruments to assess HNE remain scarce in Latin America, limiting cross-cultural research and local interventions. The aim of this study was to adapt and validate the HNE Questionnaire for the Argentine context. Using a cross-sectional, instrumental design, data were collected from 315 caregivers of children aged 3 to 8 years. Caregivers completed a self-report questionnaire assessing home numeracy activities, attitudes toward mathematics, and academic expectations. Reliability analyses showed excellent internal consistency (Cronbach's  $\alpha = .89$ , McDonald's  $\omega = .92$ ), with item–test correlations above .30. Confirmatory factor analysis (CFA) confirmed a three-factor structure comprising (a) caregivers' academic expectations regarding children's mathematical learning, (b) attitudes and beliefs about mathematics, and (c) frequency of home numeracy activities. Overall model fit indices were satisfactory, supporting the construct validity of the instrument. Findings support the questionnaire as a psychometrically robust and contextually relevant tool for Argentina. Beyond methodological contributions, the instrument provides a foundation for advancing research on socio-cultural

influences in mathematical learning and offers practical guidance for the design of early childhood educational practices and interventions.

**Keywords:** Home Numeracy Environment; Confirmatory Factor Analysis; Psychometric Validation; Caregiver Beliefs; Early Mathematics; Cultural Adaptation; Child Development

## RESUMEN

El Entorno Numérico en el Hogar (ENH) desempeña un papel fundamental en el desarrollo matemático temprano de los niños. Sin embargo, los instrumentos culturalmente adaptados para evaluar el ENH siguen siendo escasos en América Latina, lo que limita la investigación comparativa entre culturas y el diseño de intervenciones locales. Este estudio tuvo como objetivo adaptar y validar el Cuestionario de ENH para su uso en el contexto argentino. Mediante un diseño transversal de tipo instrumental, se recolectaron datos de 315 cuidadores de niños de entre 3 y 8 años. Los cuidadores completaron un cuestionario de autoinforme que evalúa actividades numéricas en el hogar, actitudes hacia la matemática y expectativas académicas. Los análisis de confiabilidad mostraron una excelente consistencia interna ( $\alpha$  de Cronbach = .89,  $\omega$  de McDonald = .92), con correlaciones ítem-test superiores a .30. El análisis factorial confirmatorio (CFA) confirmó una estructura de tres factores compuesta por (a) expectativas académicas de los cuidadores respecto al aprendizaje matemático de los niños, (b) actitudes y creencias sobre las matemáticas, y (c) frecuencia de las actividades numéricas en el hogar. Los índices de ajuste del modelo fueron satisfactorios, lo que respalda la validez de constructo del instrumento. Los hallazgos respaldan el cuestionario como una herramienta psicométricamente sólida y relevante para el contexto argentino. Más allá de su aporte metodológico, el instrumento proporciona una base para avanzar en la investigación sobre las influencias socioculturales en el aprendizaje matemático y ofrece orientación práctica para el diseño de prácticas e intervenciones educativas en la primera infancia.

**Palabras Clave:** Entorno numérico en el hogar; Análisis factorial confirmatorio; Validación psicométrica; Creencias de cuidadores; Matemática temprana; Adaptación cultural; Desarrollo infantil

## INTRODUCTION

Mathematical development begins in early childhood and is a process influenced by both individual and contextual factors. From an individual perspective, research has shown that cognitive and linguistic precursors (such as vocabulary, verbal counting, numeral recognition, phonological awareness, and visual-spatial working memory) are key foundations for early

numeracy skills (e.g., Geary et al., 2018; Krajewski & Schneider, 2009; Purpura et al., 2011). From a contextual perspective, the home environment constitutes a primary setting in which children come across numeracy-related experiences and engage with mathematical concepts through everyday interactions (Bradley et al., 2001; J.-A. LeFevre et al., 2009, p. 201; S. Li et al., 2023; Niklas & Schneider, 2013; Segers et al., 2015; Tamis-LeMonda et al., 2019).

The bioecological model of human development provides a comprehensive framework for integrating these individual and contextual influences and has been applied to the study of the home learning environment, and more specifically home numeracy environment (HNE) (Bronfenbrenner, 1976; Bronfenbrenner & Morris, 2006). This model views children's development as resulting from multiple interconnected systems, such as family, school, and community. Additionally, it describes proximal processes and distal factors that affect their development. Proximal processes are the direct educational interactions between caregivers and children, while distal factors are assumed to affect the child's development indirectly and are mediated by proximal processes. These factors are the structural family characteristics and can include home language, education, and caregivers' occupational status and beliefs (Bronfenbrenner & Morris, 2006).

This emphasis on caregivers-child interactions as contributors of development aligns with Vygotsky's sociocultural theory, which conceptualizes learning as a socially mediated process. From this perspective, caregivers function as more knowledgeable others who guide children's learning within their zone of proximal development, providing support that enables them to accomplish tasks beyond their capabilities (Vygotsky, 1978). Thus, the family microsystem described by the bioecological model can be understood as the primary context in which sociocultural mediation occurs.

Within this framework, the HNE refers to the interactions, activities and practices that take place in the home between the child and the caregiver in the context of numerical activities and caregivers' attitudes and beliefs about mathematics (LeFevre et al., 2009; Skwarchuk et al., 2014; Susperreguy, Di Lonardo Burr, et al., 2020, Hornburg, et al., 2021). These studies have distinguished between direct (formal) interactions, where teaching mathematics is intentionally targeted (e.g., using number cards, practicing counting), and indirect (informal) parent-child interactions where mathematical learning occurs incidentally and is not the central focus (Napoli & Purpura, 2018; Niklas & Schneider, 2014; Skwarchuk et al., 2014). Direct interactions have been linked primarily to the development of symbolic number knowledge, including counting, numeral recognition, and ordinality. Conversely, indirect numeracy interactions have been associated with the development of non-symbolic arithmetic skills, such as addition and subtraction, often through play-based activities (Skwarchuk et al., 2014).

These home-based experiences are particularly relevant during childhood, a developmental period when children's foundational mathematical abilities are supported through everyday

experiences. For instance, by age three, children begin to engage in early numeracy activities such as counting and number recognition, while between preschool and the early elementary years they progressively consolidate symbolic number knowledge, arithmetic reasoning, and more complex numerical concepts (LeFevre et al., 2009; Purpura et al., 2011).

Despite increased attention on the subject, findings on the relation between the HNE and children's early mathematical skills have been inconsistent. While some studies have suggested that the frequency of home-based numeracy interactions is positively associated with children's mathematical development (Kleemans et al., 2012; Manolitsis et al., 2013; Niklas & Schneider, 2014), others have found no significant relationships (e.g., Missall et al., 2015). A meta-analysis on the home numeracy experiences and young children's early numeracy learning found that, among several factors examined, such as parent education, family socioeconomic status (SES), parents' attitudes toward mathematics, expectations for children's achievement, and home numeracy activities, home numeracy experiences were the strongest predictors of preschool and kindergarten children's math performance (Dunst et al., 2017). Another meta-analysis explored the relationship between home math environment (HME, which includes all math-related activities, attitudes, beliefs, expectations, and utterances in the home) and children's mathematical performance and detected a small but statistically significant positive correlation (Daucourt et al., 2021). However, it also identified substantial heterogeneity across studies, with effect sizes varying widely depending on assessment methods, study characteristics, and sample features. Methods vary between self-report questionnaires, direct observation, diaries, or semi-structured interviews (Cosso et al., 2024; Mutaf-Yıldız et al., 2020).

Results may also vary due to cultural and regional contexts, which substantially shape family numeracy practices, expectations, and attitudes toward mathematics (Cosso et al., 2024; J. LeFevre et al., 2010; Susperreguy, Douglas, et al., 2020, McWayne & Melzi, 2014; Rey-Guerra et al., 2022). However, most studies on HNE are carried out on European and North American countries and reflect their cultural norms, expectations and education systems (Cahoon et al., 2021). Expanding the range of countries represented in the literature is important to better understand how diverse backgrounds, experiences, and cultures influence the HNE (Daucourt et al., 2021; Ellis et al., 2023).

In Latin America, recent studies have begun to address this gap (Cahoon et al., 2021; Cosso et al., 2024; del Río et al., 2017; León et al., 2021; Rey-Guerra et al., 2022; Susperreguy, Douglas, et al., 2020; Susperreguy et al., 2021, 2022). For instance, research conducted in Chile has shown that parents with more positive numeracy attitudes and lower math anxiety tend to engage more frequently in advanced numeracy practices with their children (del Río et al., 2017; Susperreguy, Douglas, et al., 2020). Susperreguy, et al. (2020) assessed the HNE using a Spanish-translated version of the Skwarchuk et al. (2014) parent questionnaire, which captures caregivers' reported frequency of home numeracy

and literacy activities, attitudes toward mathematics and literacy, and expectations regarding children's early academic skills. In Mexico and Cuba, Cahoon et al., (2024) described the importance of caregivers' expectations and attitudes toward mathematics in understanding family engagement in early numeracy, using the Pre-school Home Mathematics Questionnaire (PHMQ), a multidimensional instrument that assesses parent expectations, parent-child teaching practices, children's numeracy understanding, and the frequency of home mathematics activities, among other home environment dimensions. Moreover, Susperreguy et al. (2022), found that Mexican parents reported higher academic expectations compared to their Chilean and Canadian counterparts, based on data collected through a version of the Skwarchuk et al. (2014) parent questionnaire. In Uruguay, Leon et al. (2021) found that the frequency of number-related activities between mother and child was positively associated with preschoolers' math performance through an ad-hoc parent questionnaire with items from LeFevre et al. (2009). Additionally, recent studies focusing on Latin families residing in the United States have highlighted the importance of within-group variability in HNE practices using semi-structured interviews conducted in Spanish (Cosso, et. al., 2024).

In Argentina, empirical evidence on the HNE remains limited. A recent study assessed aspects of the HNE in 3- and 4-year-old children using an adapted version of the Early Math Questionnaire (EMQ; Missall et al., 2015) completed by the children's mothers (Noguera & Salsa, 2025). This study showed that children's engagement in home numeracy activities increased with age and was positively associated with socioeconomic status, particularly for low-demand tasks. While this work represents an important contribution to understanding HNE in Argentina, the EMQ focuses primarily on direct numeracy instruction activities and does not systematically assess indirect numeracy experiences. Moreover, the study focused exclusively on mother-child interactions, which may not reflect the diverse caregiving arrangements common in Argentina. A large proportion of children live in households where both parents participate in the labor market, and approximately one in six households is monoparental, most often headed by women (INDEC, 2022). In these contexts, childcare responsibilities are frequently shared with extended family members, particularly grandparents, or delegated to paid caregivers, especially when access to formal early childhood education and care services is limited for younger children (Enríguez et al., 2019). These non-parental caregivers are part of children's immediate microsystems and engage in proximal processes that may meaningfully contribute to early numeracy learning (Bronfenbrenner & Morris, 2006). Therefore, extending assessments beyond mother-child dyads to include diverse primary caregivers may allow for a more ecologically valid understanding of the HNE in this particular context.

In this context, the present study adapts an internationally established instrument that captures both direct and indirect numeracy experiences across diverse caregiving

arrangements. A substantial proportion of empirical research on the HNE has relied on the parent questionnaire developed by LeFevre et al. (2009), either in its original form or through culturally adapted versions (Daucourt et al., 2021). This self-report questionnaire assesses three dimensions: (a) parental academic expectations regarding skills children should master before kindergarten (e.g., counting to 10), (b) parents' attitudes toward mathematics, including past school experiences and beliefs about the importance of early math exposure, and (c) frequency of home numeracy activities over the previous month. Within the numeracy-related activities, they identified a four-factor structure comprising: number skills (such as counting objects, printing and identifying written numerals), number books, games (such as card and board games), and applications (reflecting numeracy embedded in everyday contexts). This factorial structure captured the theoretical distinction between direct numeracy instruction (number skills and number books) and indirect experiences where numeracy is embedded in authentic activities (Bjorklund, Hubertz, & Reubens, 2004). Moreover, these factors demonstrated differential predictive validity: the games factor uniquely predicted children's math knowledge, while number skills, games, and applications were associated with math fluency. Therefore, adapting the LeFevre et al. questionnaire to the Argentine context responds to the need for facilitating cross-study comparability.

In addition to the need for empirical evidence, understanding how early home experiences relate to children's mathematical achievement remains particularly relevant in Argentina. According to the national assessment *Aprender 2023* (Secretaría de Educación, 2024), only 51.5% of sixth-grade students reached a satisfactory level in mathematics, while 48.5% performed below this benchmark. When examining households from lower socioeconomic backgrounds, the percentage reaching satisfactory learning benchmarks decreases to nearly 40%. Moreover, performance in mathematics has shown little improvement over the past decade, and the proportion of students achieving advanced levels has actually decreased.

To address this gap, the present study aims to adapt and validate a questionnaire by LeFevre et al. (2009) to evaluate the HNE of children aged 3 to 8 years in the region. This age span includes both preschool and early primary school years, aligning with prior research on the HNE (LeFevre et al., 2009; Noguera & Salsa, 2025). The instrument examines caregivers' academic expectations—specifically, the importance they assign to children achieving foundational academic skills before entering preschool—their attitude towards mathematics, and the frequency of home-based activities related to both direct and indirect numeracy learning. The questionnaire has served as a foundational instrument in the field. Specifically, the study aims to (a) examine the factorial structure of the adapted instrument, (b) evaluate its internal consistency and construct validity, and (c) provide a tool for educational and psychological research that allows for the systematic assessment of caregivers' academic expectations, attitudes, and home-based numeracy practices. Although

the original instrument was administered specifically to parents, its conceptual focus on everyday numeracy interactions has supported its subsequent adaptation for a broader range of caregivers. Examining the HNE across this age range provides a developmentally sensitive framework for capturing variability in home-based numerical experiences as children transition from informal learning settings to formal schooling. This study seeks to contribute to educational psychology by advancing the understanding of contextual factors involved in mathematical development.

## METHODS

### *Study design*

The present study employed an instrumental, cross-sectional validation design aimed at the cultural adaptation and psychometric evaluation of the parent questionnaire described by LeFevre et al. (2009), assessing the HNE in an Argentine context.

### *Participants*

To assess face validity during the instrument adaptation process, a convenience sample of 10 caregivers of children between 3 and 8 years old was recruited from participants in previous studies conducted by the research team. The sample comprised 8 mothers and 2 fathers of children aged 3 (20%), 5 (30%), 6 (30%), 7 (10%), and 8 (10%) years. Regarding educational level, 4 participants had completed high school, 4 had some university coursework, and 2 had completed a university degree.

For the additional psychometric analyses, a total of 315 primary caregivers of children between 3 and 8 years of age completed the questionnaire voluntarily. Participants were recruited through online dissemination of the study invitation via social media platforms (Facebook, Instagram) between January and December 2023, through the official social media account of the research institute. The recruitment materials specified that we were seeking primary caregivers (mothers, fathers, grandparents, or other adults) responsible for the daily care of children aged 3-8 years. This broad definition of “caregiver” was adopted to reflect the diverse family structures characteristic of Argentine households, where childcare responsibilities are frequently shared with extended family members or delegated to paid caregivers (Bronfenbrenner & Morris, 2006; Enríquez et al., 2019; INDEC, 2022).

The sample included mothers, fathers, and other primary caregivers. Inclusion criteria required that participants: (a) be responsible for the daily care of a child within the specified age range, (b) reside in Argentina, and (c) have sufficient Spanish proficiency to complete the questionnaire. Data from children whose caregivers or the school reported the presence

of diagnosed developmental disorders, learning disorders, or specific language disorder were excluded from the analysis.

Of the caregivers, 88.3% were female and 11.7% were male. The mean caregivers' age was 37.77 ( $SD = 6.90$ ). The majority of participants who answered the questionnaire were children's mothers (85.08%), but it was also answered by fathers (10.79%), paid caregivers (0.95%), uncles or aunts (1.27%), grandparents (0.95%), sisters or brothers (0.64%), and stepmothers (0.32%). Regarding their educational level, 70.48% received a Bachelor's or Associate's degree, 13.33% completed some university coursework, 8.88% received a high school diploma, and 7.30% did not complete high school.

The children had a mean age of 70.84 months ( $SD = 17.87$ ) and 49.84% were female. Out of the total sample, the majority resided within the Pampas region (67%) and the Patagonia (29.5%).

### ***Materials***

**Home numeracy learning environment.** We used a self-report questionnaire designed for mothers, fathers, and caregivers of children aged 3 to 8 years. Its purpose is to assess the numeracy environment at home, and it consists of three sections: a. Caregivers' academic expectations (4 items): This section evaluates the importance caregivers place on children achieving foundational academic skills prior to entering preschool. Respondents rate each expectation on a 5-point Likert scale, ranging from Not important (1) to Very important (5). b. Home learning activities (19 items): This section measures how frequently caregivers and children engaged in numeracy-related activities at home over the past month. Participants were instructed that the questions refer to the child's everyday learning situation at home and were not limited to their direct interactions with the child. Items are rated on a 5-point Likert scale, from Never (1) to Almost every day (5). c. Caregivers' attitudes towards mathematics (5 items): This section explores caregivers' beliefs and feelings about mathematics. It includes items on past experiences with math during schooling (whether they enjoyed or felt competent in the subject), current use of mathematics in daily life or work, and beliefs about the importance of exposing their child to math-related concepts at home. Responses are given on a 5-point Likert scale, ranging from Strongly disagree (1) to Strongly agree (5). This questionnaire is based on the numeracy-related questions of the parent-report measure developed by LeFevre et al. (2009).

**Expert judgement:** To collect expert feedback we used the evaluation form described by Escobar Pérez & Cuervo Martínez, (2008) which examines four key aspects of an instrument: 1. Clarity: whether each item is easily understood, with appropriate syntax and semantics; 2. Coherence: whether each item logically corresponds to the dimension or indicator it is intended to measure; 3. Relevance: whether each item is essential for assessing

the intended indicator and should be included; 4. Sufficiency: whether the set of items within a given dimension is adequate to comprehensively measure it. Experts were asked to assign a score for each aspect using a 4-point Likert scale (1. Does not meet the criterion, 2. Low level, 3. Moderate level, 4. High level). When experts assign low scores in any of these aspects, they are asked to provide suggestions on how to revise the items, if additional items should be included, or if any existing items should be removed. Additionally, they are asked whether they believe any relevant dimension of the construct has been omitted from the evaluation.

### ***Procedure***

An extensive literature review was conducted to identify relevant instruments for assessing the HNE. We selected the parent questionnaire published by LeFevre et al. (2009) as the basis for the present instrument due to its comprehensive assessment of both direct and indirect numeracy experiences, its established psychometric properties, and its widespread use in international research. Out of the original 56 items (7 for parents' expectations, 9 for parents' attitudes toward mathematics, and 40 for home learning environment), we excluded all items related exclusively to literacy, fine motor skills, and general home activities, retaining 30 numeracy-related items. Then, three independent professionals with expertise in developmental psychology and bilingual proficiency translated the questionnaire into Spanish using a standard forward and backward translation method. Discrepancies were resolved through discussion until consensus was reached.

Following translation, a systematic process of item selection and adaptation was conducted. To this end, a panel of three experts with an average of 25 years of experience in the field was assembled. Two of the experts, who hold PhDs in child neuropsychology and educational sciences, specialize in early cognitive development, one of them specifically in the area of numeracy and mathematics. The third expert holds a Master's degree in learning psychology and has extensive experience in early childhood education. During the first iteration, suggestions were made to remove culturally irrelevant practices (e.g., playing with number fridge magnets and collecting objects) and to revise the wording of some items to improve clarity and comprehension. Additionally, a new item was introduced specifically addressing children's participation in situations involving the distribution of objects (e.g., candies, cards). During a second iteration, experts were asked to complete the Content Validity by Expert Judgment Questionnaire described by Escobar Pérez & Cuervo Martínez, (2008) over the new version of the scale. To assess face validity, this new version of the questionnaire was administered the sample of 10 caregivers who were asked to assign a score of 1 or 0 to each item to indicate whether it was clear and understandable. Then a final interview was carried out to clarify possible doubts about their answers.

Subsequently, the questionnaire was administered to the general sample (N = 315). Before completing the items, caregivers were informed about the purpose of the study and instructed to read each item carefully and respond as honestly as possible. They were asked to answer with reference to the child's daily learning situation at home, not limited to their own interactions with them.

### ***Ethics considerations***

All participants provided informed consent. Participation was voluntary, and respondents were informed of their right to withdraw from the study at any time without any negative consequences. Confidentiality and anonymity were strictly ensured throughout the research process. Personal identifying information was not collected, and all data were analyzed and reported in aggregate form. The study was approved by the Review Board for the Evaluation of Responsible Conduct in Research at the Research Institute of the Faculty of Psychology of the University of Buenos Aires (Approval code CEI22002).

### ***Data Analysis***

As measures of content validity, Gwet's AC1 coefficients (Gwet, 2014) were calculated to assess expert agreement on the clarity, relevance, coherence, and sufficiency of the items during the second iteration of the review process. Subsequently, Yusoff, (2019a) item-level and scale-level content validity index (CVI) were computed with the relevance scores. To evaluate face validity, Yusoff, (2019b) index was calculated using data from the 10 families who participated in the initial survey. Cronbach's alpha (Cronbach, 1972) and McDonald's omega (McDonald, 1999) coefficients were calculated to estimate reliability by internal consistency using the responses from the general sample and following the recommendations of the literature (Zhang & Yuan, 2016). In addition, the corrected item-total correlations were analyzed to ensure that each item contributed meaningfully to the overall construct.

To examine the factorial structure of the adapted questionnaire, a confirmatory factor analysis (CFA) was conducted. Factorability of the correlation matrix was assessed using the determinant of the correlation matrix to assess levels of multicollinearity, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, and Bartlett's test of sphericity. Given the ordinal nature of the items and the presence of five response categories, the diagonally weighted least squares (DWLS) estimator was used, which does not assume multivariate normality and is suitable for Likert-type data (Li, 2016). The model included three latent factors—caregivers' expectations (4 items), caregivers' attitudes towards mathematics, and frequency of home learning activities (19 items)—corresponding to the structure described in the original questionnaire (LeFevre et al., 2009). Model fit was evaluated using comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of

approximation (RMSEA), and standardized root mean square residual (SRMR). Good model fit was defined as CFI and TLI  $\geq .95$ , RMSEA  $\leq .06$ , and SRMR  $\leq .08$ , following (Hu & Bentler, 1999) recommendations.

The statistical analysis was done using R version 4.4.1 (R Core Team, 2024) and the packages Psych (Revelle, 2024) and Lavaan (Rosseel, 2012). Data, code used for the statistical analyses, and the final version of the questionnaire are available here: [https://osf.io/efv37/?view\\_only=a3e7784c6ce2490990ba38544b391bd6](https://osf.io/efv37/?view_only=a3e7784c6ce2490990ba38544b391bd6)

## RESULTS

Table 1 presents the items included in the final version of the Home Mathematics Environment Questionnaire, alongside relevant psychometric indicators. The table details the original item wording from LeFevre et al. (2009), the adapted Spanish version used in this study, the corrected item-total correlation coefficients (item-total  $r$ ), and the descriptive statistics (mean and standard deviation) for each item.

**Table 1**  
*Adaptation Process and Psychometric Indicators for Items in the Home Numeracy Environment Questionnaire*

Item code	Original item text (LeFevre et al., 2009)	Adapted item text	Type of activity	Item-Total $r$	M	SD
Caregivers' expectations						
Exp_Count10	Count to 10	Contar hasta 10		0,41	3,22	1,32
Exp_Count100	Count to a 100	Contar hasta 100		0,43	1,73	1,15
Exp_IdentifyNumerals	Identify/recognise written numbers	Identificar/reconocer números escritos		0,39	2,99	1,34
Exp_SimpleAdditions	Simple sums	Realizar sumas simples		0,45	1,88	1,23
Home Learning Activities						
Freq_FlashCards***	Using number or arithmetic flashcards	Jugar con tarjetas con números u operaciones aritméticas	Direct	0,47	2,85	1,23

Item code	Original item text (LeFevre et al., 2009)	Adapted item text	Type of activity	Item-Total r	M	SD
Freq_ReadNumbers	Identifying names of written numbers	Identificar los nombres de los números escritos	Direct	0,57	3,21	1,48
Freq_Magnets*	Playing with number fridge magnets	Jugar con números magnéticos de heladera o pizarra.	Direct			
Freq_CountObjects	Counting objects	Contar objetos	Direct	0,48	3,86	1,29
Freq_ArrangeObjects	Sort things by size, colour or shape	Ordenar o agrupar objetos por tamaño, color o forma	Indirect	0,49	3,12	1,52
Freq_CountBackward	Counted down (10, 9, 8, 7. . .)	Contar hacia atrás (10, 9, 8, 7..)	Direct	0,56	2,44	1,48
Freq_CarryOutAddition	Learning simple sums (i.e., 2 + 2 = 4)	Aprender sumas simples (por ejemplo, 2 + 2 = 4)	Direct	0,63	2,95	1,50
Freq_WriteDownNumbers	Printing numbers	Escribir números	Direct	0,57	3,30	1,74
Freq_TalkAboutMoney***	Talking about money when shopping (e.g., “which Costs more?”)	Hablar de dinero mientras hacen las compras (por ejemplo, “no compramos esto porque es muy caro, compramos lo otro que cuesta menos plata”)	Indirect	0,47	3,61	1,38
Freq_MeasureIngredients	Measuring ingredients when cooking	Medir ingredientes mientras cocinan	Indirect	0,45	2,76	1,45
Freq_TimedGames***	Being timed	Jugar a juegos por tiempo	Indirect	0,55	2,73	1,46

Item code	Original item text (LeFevre et al., 2009)	Adapted item text	Type of activity	Item-Total r	M	SD
Freq_Calculator***	Playing with calculators	Jugar con el celular o la calculadora para hacer cuentas (por ejemplo, jugando a comprar y vender)	Direct	0,51	2,22	1,44
Freq_Collections*	Making collections	Coleccionar objetos	Indirect			
Freq_ConnectDots	“Connect-the-dot” activities	Actividades de unir con puntos	Indirect	0,55	2,31	1,35
Freq_UseCalendars	Using calendars and dates	Usar calendarios y fechas	Indirect	0,54	2,64	1,51
Freq_UseClocks***	Having your child wear a watch	Usar o jugar con un reloj	Indirect	0,48	2,50	1,44
Freq_NumberBooks	Using number activity books	Usar libros de actividades numéricas	Indirect	0,60	2,66	1,32
Freq_StoryBooks***	Reading number storybooks	Leer libros de historias con números (leyendo el adulto)	Indirect	0,52	2,69	1,42
Freq_BoardGames***	Playing board games with dice or spinner	Jugar juegos de mesa con dados y casilleros (por ejemplo, juego de la oca)	Indirect	0,66	2,86	1,39
Freq_CardGames***	Playing card games	Jugar juegos de cartas (por ejemplo, UNO o cartas españolas)	Indirect	0,58	3,01	1,41
Freq_DistributeObjects		Actividades donde tenga que repartir cosas (por ejemplo, figuritas o caramelos)	Indirect	0,50	3,30	1,39

Item code	Original item text (LeFevre et al., 2009)	Adapted item text	Type of activity	Item-Total r	M	SD
Caregivers' attitudes						
Att_GoodAtMath**	When I was in school, I was good at mathematics	Cuando iba a la escuela, era bueno/a en matemáticas		0,25	3,54	1,19
Att_Enjoyed**	When I was in school, I enjoyed mathematics	Cuando iba a la escuela, disfrutaba las matemáticas		0,28	3,33	1,25
Att_UsingWork	The career path I have chosen is mathematics related	Mi trabajo está relacionado con las matemáticas.		0,34	2,95	1,41
Att_EnjoyToday	I find mathematics activities enjoyable	Disfruto de realizar actividades matemáticas		0,33	3,17	1,32
Att_IsImportant	It is important for my child to be exposed to mathematical concepts every day	Considero que es importante exponer a al/la niño/a a conceptos matemáticos todos los días.		0,38	3,98	1,02

*Note. All items were translated from English to Spanish. \*Items removed per expert suggestion for irrelevance. \*\*Items removed for item-total correlation < .30. \*\*\*Wording slightly modified to improve clarity.*

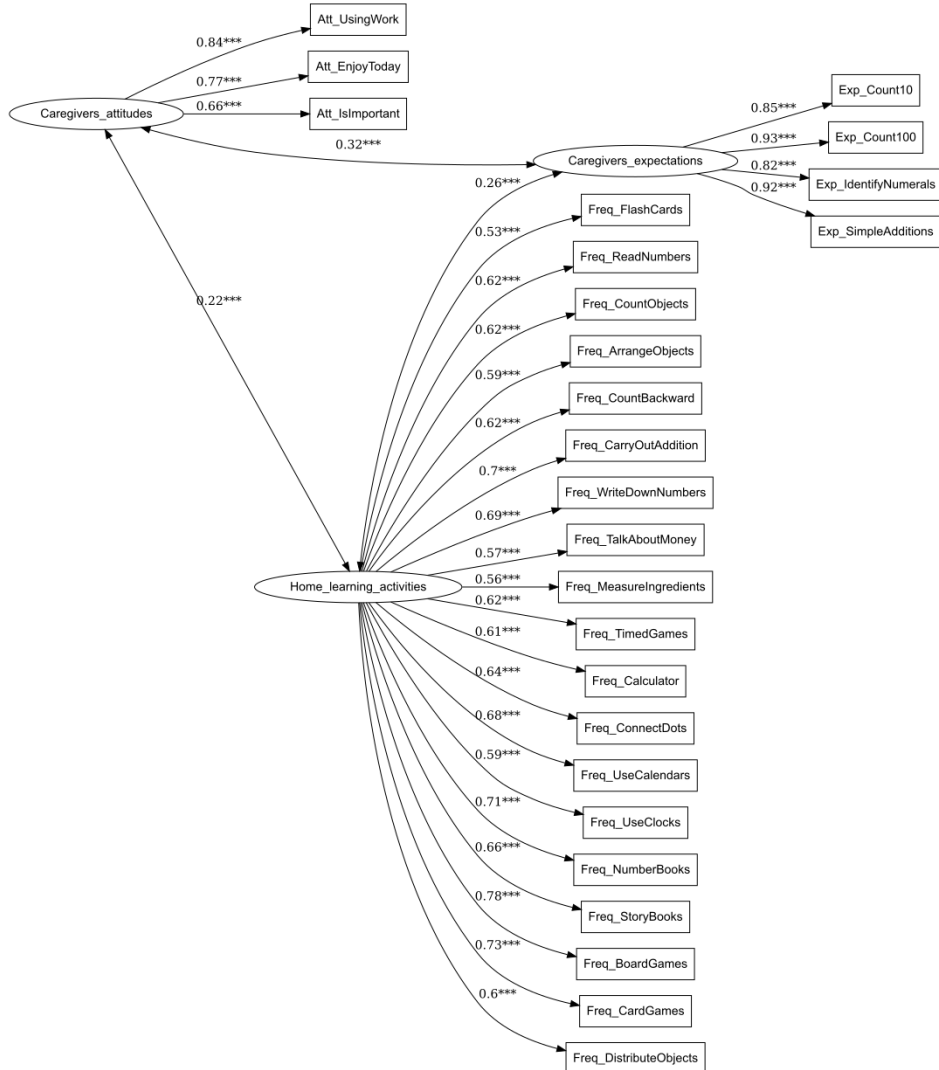
Regarding content validity, after the second expert review, the preliminary version of the questionnaire showed high levels of agreement (.79 to .90) and received moderate (3) or high (4) scores for clarity, coherence, relevance, and sufficiency. Both item-level and scale-level CVIs equaled 1.00, the recommended value when the expert panel consists of 3 to 5 members (Yusoff, 2019a). Additionally, responses from an initial sample of 10 caregivers yielded a face validity index of 0.98 (Yusoff, 2019b).

In the general sample, internal consistency was high (Cronbach's alpha = .89, 95% CI [.87, .91]; McDonald's  $\omega$  total = .92), supporting the reliability of the overall scale (see Table 1). McDonald's omega total was .92, indicating high overall reliability of the scale. However, the omega hierarchical coefficient was .27, suggesting that although a general factor accounts for some of the variance, a substantial portion is explained by specific

subdimensions. This finding supports the interpretation of subscale scores in addition to a potential global composite score.

Given the distinction between caregivers' attitudes, caregivers' expectations, and home learning activities dimensions indicated in the original version of the questionnaire, we subsequently tested a three-factor structure using CFA. The KMO measure was .86, indicating meritorious sample adequacy (Kaiser, 1974). Individual item KMO values ranged from .60 to .93. Bartlett's test of sphericity was statistically significant,  $\chi^2(25) = 119.36$ ,  $p < .001$ , suggesting that the correlations among items were sufficiently large for factor analysis. The determinant of the correlation matrix was 0.000014, indicating the absence of multicollinearity. Based on these indicators, the data were deemed suitable for factor analysis, and a CFA was subsequently conducted. The CFA model (Figure 1) demonstrated acceptable fit to the data:  $\chi^2(296) = 1120.99$ ,  $p < .001$ ; CFI = .96; TLI = .96; SRMR = .08. However, the RMSEA was slightly above recommended thresholds (RMSEA = .09, 90% CI [.08, .10]), suggesting a moderate degree of misfit. All items loaded significantly onto their respective latent factors ( $p < .001$ ), with standardized loadings ranging from .52 to .93, indicating moderate to strong associations. The three latent factors—caregivers' attitudes, academic expectations, and home learning activities—were moderately and significantly correlated ( $r = .22$  to  $.32$ , all  $ps < .001$ ). These associations support the distinction between constructs while also reflecting their conceptual interrelatedness.

**Figure 1**  
*Confirmatory Factor Analysis of Caregivers' Attitudes, Expectations, and Home Numeracy Activities*



Note. All path coefficients are standardized. \*\*\* $p < .001$ .

A more complex four-factor model separating indirect (e.g. playing card games) and direct (e.g. carrying out additions) home learning activities was also tested. Although the scaled chi-square difference test indicated a significant improvement in model fit ( $\Delta\chi^2_{(3)} =$

45.23,  $p < .001$ ), no other indices over those obtained with the more parsimonious three-factor solution. Following the literature, we selected the three-factor solution, as model parsimony is preferred when fit is equal (Kline, 2023, Hu & Bentler, 1999).

Table 2 shows descriptive statistics for the subscale scores and total score derived from the HNE Questionnaire with 26 items (caregivers' attitudes = 3, caregivers' expectations = 4, home learning activities = 19), for the complete sample. Skewness values ranged from -0.22 to 0.70 and kurtosis values from -0.58 to -0.26, indicating approximately normal distributions across all subscales (Kline, 2023).

**Table 2**  
*Descriptive statistics for Home Numeracy Environment Questionnaire*

	<b>M</b>	<b>SD</b>	<b>Min</b>	<b>Max</b>	<b>Skewness</b>	<b>Kurtosis</b>
Caregivers' attitudes	10,1	2,94	3	15	-0,19	-0,74
Home learning activities	55,01	16,18	21	114	0,30	-0,26
Caregivers' expectations	9,83	4,3	4	20	0,70	-0,37
Total Score	81,81	19,16	39	138	0,15	-0,57

## ***Discussion***

The present study aimed to adapt and validate a questionnaire to assess the HNE in Argentina, focusing on three dimensions: caregivers' academic expectations, attitudes toward mathematics, and the frequency of home numeracy activities. The results provide initial evidence for the reliability and validity of this culturally adapted instrument, supporting its use to capture numeracy-related interactions within Argentine families.

Unlike broader conceptualizations of the Home Learning Environment (HLE), the present work concentrated specifically on numeracy-related aspects. While the literature recognizes that the home mathematics environment encompasses a range of mathematical and non-mathematical activities, our adaptation prioritized numeracy items to align with the original LeFevre et al. (2009) questionnaire and to respond to the limited availability of culturally relevant measures in this domain for Argentina. This focus was also informed by the expert panel's recommendation to exclude items that were not widely practiced or culturally meaningful in the local context (e.g., certain play materials uncommon in Argentine households) and to add items reflecting typical numeracy experiences (e.g., distribution of objects during daily routines).

The confirmatory factor analysis supported a three-factor solution—caregivers' attitudes, caregivers' academic expectations, and frequency of numeracy activities—closely aligned with the structure proposed in the original instrument. These dimensions

can be understood within the bioecological framework as representing both distal and proximal influences on children's mathematical development (Bronfenbrenner & Morris, 2006). Caregivers' academic expectations reflect beliefs about the importance of early skill acquisition and the developmental readiness required for formal schooling. These expectations function as distal factors that shape caregivers' decisions about which learning opportunities to provide and how much emphasis to place on academic preparation in the home environment (Susperreguy et al., 2020). Caregivers' attitudes toward mathematics encompass affective and cognitive orientations toward the domain, including perceived competence, past experiences, and beliefs about the value and utility of mathematics. These attitudes can influence not only the frequency of numeracy interactions but also their emotional tone and pedagogical quality (Maloney et al., 2015). Finally, the frequency of home numeracy activities represents the proximal processes through which children are directly exposed to numerical content, providing opportunities for practice, skill consolidation, and conceptual development through everyday interactions (LeFevre et al., 2009; Skwarchuk et al., 2014).

However, unlike models that distinguish between formal (direct) and informal (indirect) numeracy interactions (Hart et al., 2016; Skwarchuk et al., 2014), all activity items in our data loaded onto a single factor. This suggests that caregivers may not differentiate between direct teaching and incidental numeracy experiences, instead viewing them as part of a broader and integrated approach to supporting children's mathematical learning. This pattern differs from findings reported in North American and European samples, where distinctions between direct and indirect practices are more clearly observed. It highlights the importance of understanding the HNE not only as an individual household factor, but also as part of a broader ecological system shaped by cultural, socioeconomic, and educational contexts (Bronfenbrenner & Morris, 2006). This interpretation is supported by evidence from other Latin American settings, where mathematical learning often emerges in naturally occurring, socially embedded contexts (del Río et al., 2017; Rey-Guerra et al., 2022).

The association between caregivers' positive attitudes toward mathematics and both expectations and activity frequency underscores the role of beliefs in shaping home learning opportunities (Maloney et al., 2015; Susperreguy, et al., 2020). In our sample, higher expectations for children's early academic skills were linked to more frequent engagement in numeracy activities, suggesting that expectations may serve as a motivational driver for participation in math-related interactions. Notably, previous work in Mexico and Chile has shown cultural differences in the strength and nature of this association (Susperreguy et al., 2021; Cahoon et al., 2024), indicating that cross-cultural comparisons using this instrument could shed light on the specific ways in which Argentine families prioritize and enact numeracy support. For example, it may reflect sociocultural norms in which

academic learning and everyday life are less compartmentalized than in some North American or European contexts. Moreover, the emphasis on early expectations aligns with prior studies indicating that Argentine caregivers value early preparedness for school entry, even in informal learning domains (Noguera & Salsa, 2023). Such cultural features reinforce the importance of developing and validating measurement tools that are sensitive to local practices, beliefs, and educational structures.

From an educational psychology perspective, these findings contribute to refining theoretical models of the HNE by showing both structural convergence with prior research and context-specific variations in the organization of numeracy practices. The results underscore the need to incorporate cultural variability into models linking parental beliefs, motivational orientations, and children's early mathematical development. At the same time, the availability of a validated instrument for the Argentine context enables the systematic assessment of family-level psychological factors associated with early mathematics learning, supporting evidence-based intervention design and school-family articulation strategies.

Despite its contributions, this study has limitations. From a methodological perspective, the reliance on self-reported data introduces potential biases related to social desirability and recall accuracy, which may lead to over- or underestimation of engagement in numeracy-related activities. Incorporating complementary methods, such as structured observations, time-use diaries, qualitative interviews or reports from multiple caregivers, could strengthen the ecological validity of future research. In addition, while the sample captured variability in caregivers' education, it was not representative of all socioeconomic strata in Argentina. Given prior evidence that socioeconomic factors shape both the frequency and nature of numeracy interactions (de León, 2021; Noguera & Salsa, 2023), expanding the sample to include more diverse households will be critical to testing the stability of the factor structure and the generalizability of the findings. Finally, the relatively small proportion of non-maternal caregivers in our sample precluded meaningful statistical comparisons across caregiver types, a limitation that future research with more balanced samples should address by examining whether different caregivers report home numeracy practices differently.

In summary, this study contributes to HNE research by providing a psychometrically sound, culturally adapted tool for Argentina. The instrument enables cross-cultural comparisons within Latin America and beyond, fostering a more inclusive understanding of how home environments shape children's mathematical development. The originality of the present study lies primarily in its methodological and contextual contribution. Specifically, this is the first study to culturally adapt and validate the LeFevre et al. (2009) questionnaire for the Argentine context. The findings offer understanding into how caregivers conceptualize numeracy practices and underscore the value of culturally grounded measurement for advancing early numeracy research and informing context-responsive policies and interventions. In particular, the tool could inform educational policy by

identifying areas where families may need support in promoting numeracy. Furthermore, it could also be used in teacher training programs to raise educators' awareness of the diversity of home numeracy practices.

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