Psychometric Validation of Home Numeracy Experience and Early Math Competence Measures among Preschool Children in Addis Ababa

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Received:28 September 2025; Accepted:1 October 2026

Abstract: *Early mathematics competence is an important foundation for later academic learning; however, evidence on home numeracy experience (HNE) and culturally appropriate early mathematics assessment remains limited in Ethiopia. This study examined the preliminary psychometric properties of an adapted HNE Questionnaire and a researcher-developed Early Math Competency Test (EMCT). The study sampled 105 preschool children (50 boys and 55 girls) from Dandii Boru School using systematic random sampling and their parents. Children completed a 25-item EMCT assessing number and operations, algebra/patterning, geometry/shape, and measurement. Parents completed a questionnaire assessing home numeracy activities, expectations of children's numeracy competence, and attitudes toward mathematics. Expert review supported the content validity of the EMCT (S-CVI/Ave = .96) and HNE Questionnaire (S-CVI/Ave= .88). Exploratory factor analysis identified a three-factor structure for the EMCT and a four-factor structure for the adapted HNE Questionnaire. However, the HNE factor structure did not fully replicate the proposed theoretical sub-scales. Except for the Games sub-scale (α = .45), the EMCT and overall HNE Questionnaire demonstrated good internal consistency (KR-20 = .82) and reliability (α = .85) respectively. EMCT scores were positively associated with Number Skills (r = .535), Number Books (r = .515), Games (r = .523), and Applications (r = .610). Parents' expectations of children's numeracy competence and attitudes toward mathematics were not significantly associated with EMCT scores. Findings supported the premise that parent-reported*

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everyday numeracy activities are associated with preschool children's early mathematics competence, highlighting both parent support and home environment bring meaningful change in early numeracy learning.

Keywords: *early mathematics competence, home numeracy experience, psychometric validation, preschool children.*

Introduction

Numeracy skills acquired during the early childhood period are the building blocks of academic achievement, school readiness, and lifelong learning. Longitudinal studies have found that mathematics skills assessed during preschool years predict later mathematics performance and overall school achievement (Duncan et al., 2007; Soto- Calvo et al., 2019). Recent studies also support early mathematics competence as a robust predictor of later academic achievement and readiness for school (Bonifacci et al., 2021; Vanbecelaere et al., 2021). Extensive research attention has been devoted to documenting contributors to early math skill development. Home Numeracy Experience (HNE) refers to children's exposure to the range of learning opportunities, activities, didactic materials, parental beliefs, and interactions at home that involve mathematics learning (Kleemans et al., 2012; LeFevre et al., 2009). Formal and informal home numeracy activities contribute to children's early math skill development; however, variability exists in reported strength and direction of these associations by math domain and socio-cultural context (Girard et al., 2025; James-Brabham et al., 2025).

Home numeracy learning opportunities are supported by theoretical perspectives asserting that home serves as children's first context for learning (Shonkoff & Phillips, 2 000; Weisner, 2002). While interacting with parents/caregivers and exploring their world, children learn fundamental math knowledge that contributes to later academic success. Early numeracy-related interactions at home may include counting toys and books, playing number board games, reading books

about numbers, shopping at the grocery store, cooking together, and cleaning the house (Napoli & Purpura, 2018). Indeed, longitudinal studies found that preschoolers with rich numeracy experiences at home, scored higher on measures of number knowledge, counting skills, and mathematical problem-solving compared to their peers (Duncan et al., 2007; Girard et al., 2025).

Although research attention has been given to examining HNE among children from WEIRD societies; there is limited understanding of how culture, language, and contextual factors shape home learning environments and early mathematics development in culturally and linguistically diverse contexts. Preliminary evidence from studies conducted in non-Western countries indicate that socio-cultural expectations about education and parenting may differentially structure home numeracy activities and associations with children's mathematical skills (Pan et al., 2023). Socioeconomic status has also been found to differentially impact children's mathematical skills through children's home numeracy experiences (Bonifacci et al., 2021).

Ethiopia's educational system, languages spoken, and socio-demographic landscape may contribute to learning opportunities and skills Ethiopian children possess prior to school entry. Ethiopia is home to over 40 different languages that serve as children's mother tongues during their education. Language spoken at home may shape the home numeracy activities Ethiopian children engage in and how they understand instructions and items on standardized measures (Fessha, 20 22). Additionally, parent education and families' resources may contribute to variability in home numeracy experiences Ethiopian children have prior to school. Given the unique Ethiopian context, it is necessary to examine home numeracy experiences that Ethiopian children are exposed to and create valid tools for measuring both home numeracy experiences and children's early math competence. Thus, the current study seeks to provide preliminary psychometric information about an adapted Home Numeracy Experience Questionnaire and a

newly developed Early Math Competence Test among preschool children in Addis Ababa, Ethiopia. Additionally, it is essential to explore the relationship between dimensions of HNE and children's early math competence.

Research Problem

Children's mathematical competence in the preschool years is strongly associated with later academic achievement and school readiness. Home numeracy experiences have received considerable research attention because parents and the home learning environment can influence children's early mathematical development. Although research has established the importance of home numeracy experiences for children's mathematical development in many parts of the world,

Definitions

Conceptual Definition: Home Numeracy Experience refers to the mathematical interactions, activities, resources, and learning opportunities that children experience within the home environment through engagement with parents or caregivers (LeFevre et al., 2009; Daucourt et al., 2021).

Operational Definition: In this study, Home Numeracy Experience refers to the frequency with which children engage in numeracy-related activities at home. It was measured across four areas: Number Skills Activities, Number Book Activities, Games Activities, and Application Activities. Higher scores show that children take part in these numeracy activities more often at home, most studies have been conducted in Western countries. Ethiopia is socio-culturally and linguistically different from many of the contexts in which widely used home numeracy experience questionnaires were developed and validated. Using Western-developed instruments without examining their validity in the Ethiopian context may limit the accurate

understanding of the nature and extent of home numeracy experiences among Ethiopian children.

Similarly, using mathematics competence tests developed and validated in Western contexts without adequate cultural and contextual adaptation may provide an incomplete or potentially distorted assessment of Ethiopian children's mathematical abilities. Therefore, examining the psychometric properties of an adapted Home Numeracy Experience Questionnaire and a newly developed Early Math Competence Test are important for generating contextually appropriate evidence on Ethiopian parents' home numeracy practices and Ethiopian preschool children's mathematical **competence**.

Research Questions

This study intended to evaluate the psychometric properties and contextual appropriateness of the adapted Home Numeracy Experience Questionnaire and the newly developed Early Math Competence Test in the Ethiopian context. The study was guided by the following research questions:

What are the psychometric properties and contextual validity of the adapted Home Numeracy Experience Questionnaire and the Early Math Competence Test in the Ethiopian context?

To what extent are the dimensions of home numeracy experience associated with preschool children's early mathematics competence?

Methodology

Research Design

This study primarily employed a quantitative instrument-validation design to adapt and evaluate two measures for Addis Ababa preschoolers: an adapted Home Numeracy Experience questionnaire and a newly developed Early Math Competence test. Validation procedures included content review with local experts, exploratory factor analysis (EFA) and internal consistency reliability assessment to ensure psychometric soundness prior to hypothesis testing. As a secondary step to support construct validity, correlational analyses were used to examine expected relationships between home numeracy sub-themes, parental attitudes/expectations, and children's early math competence. These correlational analyses are presented as validity evidence for the adapted instruments rather than as an independent aim.

Study Setting

This study was conducted at Dandii Boru School, a well-established private educational institution located in Addis Ababa, within the Kirkos Sub-City. The school offers educational services from kindergarten through grade 12 and is recognized for its strong emphasis on early childhood education. It was purposefully selected as the study site based on the assumption that parents are actively involved in home learning activities in general, and in home numeracy practices to complement school instruction.

Participants

Participants were 105 Level-3 preschool children (50 boys and 55 girls) and their parents from Dandii Boru School, a private preschool in Addis Ababa. The school was selected because of its active community support for children's home education. The study population consisted

of 139 Level-3 preschool children and their parents. A systematic random sampling procedure was employed to select 105 participants, representing approximately 76% of the target population. The sample size was determined based on an a priori power analysis conducted using G*Power 3.1 (Faul et al., 2009). Assuming a medium effect size (r = .30), a significance level of .05, and statistical power of .80, the analysis indicated a minimum sample size of 84 participants. Therefore, the final sample of 105 participants exceeded the minimum requirement and was considered adequate for detecting statistically meaningful relationships among the study variables. Inclusion criteria required that (a) the child was enrolled in the preschool program, (b) the parent or primary caregiver was directly involved in the child's daily learning activities, and (c) both parent and child consented to participate. Participation was voluntary, and confidentiality was maintained using coded identifiers. Ethical approval was obtained from the relevant institutional review board prior to data collection.

Procedure

Data were collected over a three-week period. After providing informed consent, parents completed the Amharic version of the self-administered questionnaire, which had been back-translated from English to ensure accuracy and cultural relevance. Children were individually assessed with the Early Math Competency Test in a quiet classroom setting by trained early childhood educators.

Measures

Data were gathered using four instruments, including a researcher-developed Early Math Competency Test (EMCT) for children and a Parent Survey measuring home numeracy practices, parents' expectation regarding their child's numeracy skills, and parents' attitudes toward mathematics. Results of psychometric analyses

demonstrated that the measures possessed good validity and reliability.

Early Math Competency Test (EMCT): The EMCT was a 25-item performance-based test designed to measure preschool children's competence in counting, number identification and comparison, basic mathematical operations (addition, subtraction), patterning, geometry and shapes, and measurement skills using objects and toys as recommended by the Ethiopian preprimary curriculum and classroom guide (Ministry of Education, 2021). Content validity was established through expert evaluation with excellent I-CVI and S-CVI (UA). Construct validity was supported by the principal component analysis which largely confirmed the seven-domain theoretical structure. Reliability was established using the Kuder–Richardson 20 formula = .815. In sum, the EMCT showed excellent validity and good internal consistency reliability for measuring young children's early math competencies in Ethiopia.

Home Numeracy Experience Questionnaire: Parents' frequency of engaging children in numeracy experiences at home was assessed using an adapted version of the Home Numeracy Experience (HNE) questionnaire developed by LeFevre et al. (2010). The 13 items were adapted to fit the Ethiopian context and yielded scores in four theoretically-derived HNE domains: Number Skills, Number Books, Number Games, and Number Applications. Participants were asked to indicate how often their preschool-aged children engaged in the described activities on a 5-point Likert scale (0 = did not occur to 4 = almost daily). Content validity was examined by reviewing ratings from multiple experts. Exploratory factor analysis using principal axis factoring provided preliminary support for the internal-structure validity of the HNE. The analysis produced a multidimensional solution that was congruent with the idea that parents participate in a variety of activities with their children at home. However, the rotated solution did not reproduce the four HNE domains. As such, the findings involving individual HNE dimensions were reported with caution. Nonetheless,

the total score on the HNE demonstrated good internal consistency in the present study (α = .854).

Parents' Expectation of Numeracy (PEN) Scale: Parents' expectations about their children's ability to perform certain numeracy tasks before starting school were measured using a 10-item PEN scale adapted from Skwarchuk et al. (2014). Items were answered on a 3-point Likert scale (1 = if your child cannot do this yet to 2 = if your child can do this easily). Reliability analysis showed acceptable internal consistency (α = .761).

Attitudes toward Mathematics Inventory (ATMI): Parents' attitudes toward mathematics were assessed using an adapted version of the Attitudes toward Mathematics Inventory (Tapia & Marsh, 2002). The scale measures both affective and cognitive attitudes parents endorse toward mathematics as well as its importance for children's education. Parents responded to nine items on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The abbreviated scale showed acceptable internal consistency reliability (α = .734) in this study.

Instrument adaptation: Three sets of analyses were conducted to establish measurement equivalence for the adapted instruments. First, experts reviewed all translated instrument items and revised items as necessary based on I-CVI ratings. Next, EFA using parallel analysis and oblique-rotated principal axis factoring confirmed items retained loaded onto theoretical constructs with sufficient magnitude (> .32) and no cross-loadings. Lastly, it was checked for acceptable internal consistency reliability for Likert-type subscales (Cronbach's alpha and item-internal correlations ≥ .30) and KR-20 coefficients for items with dichotomous response options. These analyses, together with evidence of content validity established through expert review of translated items supported by acceptable content validity indexes (CVI), indicated the suitability of our instruments for assessing home

numeracy practices and early math competencies of preschool children living in Addis Ababa.

Data Analysis

Data were analyzed using SPSS 26 after checking for data accuracy, normality, and missing values. Due to the nature of this study (instrument adaptation and validation), content validity of the adapted Home Numeracy Experience Questionnaire and newly developed Early Math Competency Test were calculated using I-CVI and S- CVI (Ave and UA) among expert raters. Construct validity of both instruments were examined by conducting principal axis factoring with Varimax rotation. Internal consistency reliability for the instruments was calculated using Cronbach's alpha coefficients for the Likert type subscales and KR-20 for the dichotomous scales. Evidence of convergent (construct related) validity was assessed by correlating dimensions of Home Numeracy Experience with children's scores on the Early Math Competency Test.

Results

Demographic Characteristics

Table 1 displays the frequencies and percentages of demographic variables of parents/caregivers and children who participated in this study. Most parents who participated in this study were fathers (n = 76, 72.4%), followed by mothers (n = 19, 18.1%) and caregivers (n = 10, 9.5%). Most parents' ages ranged from 35–44 years old (n = 61, 58.1%), followed by 25–34 years old (n = 33, 31.4%), and 45 years older (n = 11, 10.5%). Most respondents (n = 36, 34.3%), were college diploma holders; followed by respondents with bachelor's degrees (n = 26, 24.8%) and high school education (n = 29, 27.6%). Fewer participants had master's degrees and above (n = 12, 11.4%), while only two (1.9%) of participants indicated they had a primary education.

Overall, these data suggest that our sample had relatively high levels of education.

Table 1: *Demographic Characteristics of Parents, Caregivers, and Children (N = 105)*

Variable	Category	n	%
Relationship to Child	Father	76	72.4
	Mother	19	18.1
	Caregiver	10	9.5
Age of Parents (Years)	25–34	33	31.4
	35–44	61	58.1
	45 and above	11	10.5
Education Level	Primary Education	2	1.9
	High School Education	29	27.6
	College Diploma	36	34.3
	Bachelor's Degree	26	24.8
	Master's Degree & above	12	11.4
Parent Employment Status	Non-government employee	57	54.3
	Own Business	36	34.3
	Government Employee	6	5.7
	No Response	6	5.7
Family Income (Annual)	Less than 500,000 Birr	13	12.4
	500,000 – 1,000,000 Birr	72	68.6
	Greater than 1,000,000 Birr	20	19.0
Child Age	6 Years	94	89.5
	7 Years	11	10.5
Child Gender	Girl	55	52.4
	Boy	50	47.6

Regarding employment status, most parents reported being employed in non-government sectors (n = 57, 54.3%), followed by parents who had their businesses (n = 36, 34.3%). The remaining participants were either employed by the government (n = 6, 5.7%) or did not report their employment status (n = 6, 5.7%).

Annual family incomes ranged from 500,000 – 1,000,000 Ethiopian Birr reported by most of the families (n = 72, 68.6%), followed by families whose income was greater than 1,000,000 Birr/year (n = 20, 19.0%). Ethiopian Birr 500,000 or less was the annual income reported by the least of our participants (n = 13, 12.4%). Based on the Ethiopia Bureau of Income Statistics calculation and designations, our participants were predominantly middle-income class families. Six-year-old children made up majority of the sample (n = 94, 89.5%), and seven-year-old children were the minority (n = 11, 10.5%). Girls made up 52.4% (n = 55) of the sample and boys made up 47.6% (n = 50). Having nearly equal number of boys and girls in the study allowed for comparison between both genders. The sample was recruited from a good background as most parents had at least high school education, most were employed, and most fell under the middle-income class category.

Content Validity

To determine the relevance and representativeness of each item on the *Early Math Competency Assessment*, five experts from early childhood field rated each item on a 4-point scale (i.e., 1 = Not relevant, 4 = Highly relevant). The resulting I-CVI was calculated by taking the number of experts who gave a rating of either 3 or 4 and dividing by the total number of experts. Experts who participated in this phase of validation were three Early Childhood Experts from Addis Ababa City Administration Education Bureau and two preschool teachers who have worked for at least three years in public preschools. All items had I-CVI values ranging from 0.80 to 1.00, with 20 (80%) of the items receiving a 1.00 (indicated experts' agreement) and the remaining five items receiving .80 indicating slight disagreements among experts. The resulting S-CVI/Ave was .96 which is above the recommended level of .80 suggesting that the content of the scale covers the construct domain of early numeracy skills and mathematical reasoning among preschool children (Polit & Beck, 2006). Furthermore, the universal agreement index (S-CVI/UA) was 0.80 demonstrating that most items were given a unanimous rating by the experts. Thus, the findings from

the content validity assessment suggest the items used to measure early numeracy skills represent the targeted domains. The table shows experts' ratings and resulting CVIs (refer to Appendix A).

Content Validity of Home Numeracy Experience Survey. Following a similar process to that described above, experts in early childhood field also rated each item on Home Numeracy Experience Survey adapted and translated into Amharic language for use in Ethiopia on a 4-point scale (i.e., 1 = Not relevant, 4 = Highly relevant). The resulting I-CVI values ranged from 0.60 to 1.00 and the S-CVI/AVE was 0.88 which is above the acceptable level of 0.80 (Polit & Beck, 2006). The universal agreement index was 0.54 demonstrating moderate agreement among raters. Most items had I-CVI values of 0.80 or greater which provides evidence that the items measure constructs relevant to home numeracy experiences. Only two items (10 and 11) had I-CVI values of .60 which may need further refinement to establish better conceptual understanding and cultural representation among respondents. The table demonstrates experts' ratings and calculated indices (refer to Appendix- B).

Construct Validity of the Adapted Home Numeracy Experience Questionnaire

An exploratory factor analysis (EFA) was performed to provide preliminary evidence of internal-structure validity for the adapted HNE Questionnaire. Principal axis factoring with Varimax rotation and Kaiser normalization was conducted to determine the underlying organization of the retained home numeracy activity items. Factor retention was informed by eigenvalues greater than 1.00, percent of variance explained, interpretability of the rotated factor solution, and size of factor loadings.

Table 2: *Total Variance Explained by the Retained Factors of the HNE Questionnaire*

Factor	Eigenvalue	% Variance	Cumulative %
1.	5.681	47.345	47.345
2.	1.884	15.702	63.047
3.	1.323	11.025	74.072
4.	0.823	6.858	80.930

Note. *Three factors exceeded the Kaiser criterion (eigenvalue > 1.0). A fourth factor was retained based on the theoretical multidimensional structure of the Home Numeracy Experience framework.*

As shown in Table 2, the first three factors had eigenvalues greater than 1.00 and together explained 74.07% of the variance. A fourth factor with an eigenvalue less than 1.00 (λ = .823) was retained for exploratory purposes. The retention of three or four factors was deemed appropriate given that the conceptualization of home numeracy experience as measured by the HNE framework is multidimensional in nature (specifically Number Skills, Number Books, Number Games, and Number Applications). The four-factor solution explained 80.93% of the total variance in responses. Although this strengthened the EFA's support for multiple dimensions of parents' reported home numeracy activity, caution should be used in interpreting the fourth factor because it did not meet the Kaiser criterion.

The rotated factor-loading matrix is shown in Table 3. Factor 1 was composed of Number Book 1, Number Skill 5, Number Application 1, Number Skill 4, Number Skill 6, Number Skill 3, and Number Game 1. All factor loadings were adequate (ranging from .408 to .968), and this factor was considered to represent a general direct home numeracy activity dimension. Factors 1's breadth was due to its mixture of items that were originally part of separate dimensions (number skills, number

books, number games, and number applications). Within the current sample, parents may perceive these activities as related components of informal numerical support, rather than completely distinct activities.

Table 3: *Rotated Factor Loadings for the Home Numeracy Experience Questionnaire*

Item	Factor 1: Direct Home Numeracy Activities	Factor 2: Book- and Game-Based Activities I	Factor 3: Book- and Game-Based Activities II	Factor 4: Foundational Number Skills
Number Book 1	0.968			
Number Skill 5	0.853			
Application 1	0.783			
Number Skill 4	0.775			
Number Skill 6	0.751			
Number Skill 3	0.669			
Game 1	0.408			
Number Book 2		0.972		
Game 3		0.918		
Number Book 3			0.961	
Game 2			0.824	
Number Skill 1				0.512
Number Book 1	0.968			

Note. *Principal axis factoring with Varimax rotation was used. Factor loadings ≥ .40 are reported. Number Skill 2 cross-loaded on Factors 1 and 4. Item labels correspond to the final adapted questionnaire.*

Factor 2 consisted of Number Book 2 and Number Game 3, whereas Factor 3 consisted of Number Book 3 and Number Game 2. The cross-loadings within Factors 2 and 3 were high enough to conclude that the items that defined each factor were related. However, Factors 2 and 3 should be interpreted with caution due to their instability (each factor was defined by only two items). Factor 4 was primarily defined by a

single item, Number Skill 1. Number Skill 2 cross-loaded on Factors 1 and 4. Due to its cross-loading, Number Skill 2 did not appear to represent a single dimension well. Accordingly, Factor 4 was not considered to represent an independent sub-scale with any degree of stability.

The EFA provided mixed support for the factor structure of the adapted HNE Questionnaire. The overall EFA supported the conclusion that parents' self-reported home numeracy activity is multidimensional. However, the rotated factor solution did not replicate the theoretical structure of four separate dimensions (number skills, number books, number games, and number applications). Instead, items from each of those dimensions loaded onto a general home numeracy activity factor, while book-related and game-related items loaded onto mixed two-item factors. Therefore, the current EFA results should be considered preliminary support for the adapted HNE Questionnaire's ability to measure multiple dimensions of home numeracy experience among the Ethiopian sample.

For the current study, the questionnaire was utilized to measure parents' self-reported home numeracy activity and to examine its relationship to their preschool children' mathematical competence. These results do not provide evidence of full construct validity regarding the existence of four distinct HNE subscales. Further research should revise the item pool to better reflect the subscales' original structure, retain at least three conceptually similar items for each subscale, and test the resulting factor structure using confirmatory factor analysis with an independent Ethiopian sample.

Construct Validity of the EMCT

***Table 4**: Total Variance Explained by the Extracted Factors for the EMCT*

Factor	Eigenvalue	% Variance	Cumulative %
1	2.496	31.20	31.20
2	1.464	18.30	49.50
3	1.186	14.82	64.32

***Note.** Extraction method: Principal axis factoring. Only the first three factors had eigenvalues greater than 1.00 and were retained.*

Table 4 presents the eigenvalues and percent of variance explained by the first four factors extracted from the EMCT using principal axis factoring. According to the Kaiser criterion (eigenvalues > 1.00), three factors should be retained. The first factor had an eigenvalue of 2.496 and explained 31.20% of the variance. The second factor had an eigenvalue of 1.464 and accounted for 18.30% of the variance. Finally, the third factor had an eigenvalue of 1.186 and explained 14.82% of the variance. Together, the three extracted factors explain 64.32% of the variance. This value exceeds the benchmark of 50% that is typically considered acceptable in educational and psychological research. The final factor had an eigenvalue less than 1.00 (λ = .805), which means that it explained less variance than a single observed variable and was therefore dropped. The amount of variance explained by the first three factors together provides statistical evidence in support of early math competency being multidimensional in the present sample.

As can be seen in Table 5, the Promax (oblique) rotation converged in four iterations and resulted in a simple three-factor solution. Because an oblique rotation was performed, the pattern matrix (rather than the structure matrix) will be interpreted. The pattern matrix shows each item's correlation with its primary factor while controlling for (or removing) all other factors' correlations. Items were screened using a

more conservative criterion of .30 or greater. The rotated solution showed that factors loaded nicely on their respective subscales with few cross-loadings.

***Table 5**: Pattern Matrix for the EMCT*

Item	Factor 1	Factor 2	Factor 3
Simple Addition	.990	-	-
Number Comparison	.508	-	-
Measurement	.497	-	-
Counting	-	.800	-
Number Identification	-	.751	-
Identifying Shapes	-	-	.687
Shape Attributes	-	-	.441
Patterning	-	-	.415

***Note.** Loadings < .30 are suppressed. Extraction method: Principal axis factoring. Rotation method: Promax with Kaiser Normalization.*

As presented in Table 5, Factor 1 was primarily consisted of Simple Addition (.990), Number Comparison (.508), and Measurement (.497). The loading for Simple Addition was .990, showing that this item clearly defines factor 1, or the first latent construct. Because Number Comparison and Measurement loaded at moderate levels, and they make conceptual sense together, this factor can be interpreted as indexing children' abilities in arithmetic reasoning and quantitative problem-solving. Together, these items form a unitary scale that can be interpreted to represent operations and quantitative reasoning as a domain of early math competence.

Factor 2 had high loadings for Counting (.800) and Number Identification (.751). Both items loaded at or above .70, demonstrating strong inter-relatedness between these items. These items index children's knowledge of symbolic numbers, specifically their ability to recite the number sequence and knowledge of number names. Due to their strong loadings, it can be concluded that this represents a

cohesive factor. Thus, Factor 2 can be interpreted to represent early knowledge of numbers.

Factor 3 consisted of Identifying Shapes (.687), Shape Attributes (.441), and Patterning (.415). Shape Attributes and Patterning were moderate loadings but above the accepted threshold for loading on a factor. Together, these three items make theoretical sense to form a factor that indexes early skills in geometry and visual patterns. Patterning had a secondary loading of .257 on Factor 1; however, this is not considered a cross-loading because it was less than .30 and much smaller than the primary loading. Overall, there were few cross-loadings which suggests that simple structure was obtained.

The pattern matrix shows good factor structure. No variables loaded greater than .30 on more than one factor. This shows that there is discriminant validity between the three factors. The items loaded onto their theoretical factors, showing evidence of a multidimensional structure of early mathematics competence within the current sample. Additionally, the loadings of each item were quite high (.80 or greater on 5 of the 8 items). While some items may be considered weak (e.g., Shape Attributes and Patterning), their loadings were above .40 and they loaded onto their theoretically appropriate factors. Therefore, these items should be retained for the spatial factor.

In conclusion, the rotated factor solution provides evidence of a three-factor structure. The three factors can be interpreted as follows: (a) Arithmetic and Quantitative Reasoning, (b) Knowledge of Numbers, and (c) Spatial Sense Geometry and Patterning. The decision to retain these three factors and their respective groupings is due to the clear pattern matrix, lack of major cross-loadings, and clear meaning behind each factor. This provides evidence that the EMCM is valid in terms of construct.

Reliability Analysis

Table 6: Reliability Statistics for HNE, PEN and PAM

Variable	No. of Items	Reliability Coefficient
Home Numeracy Experience (HNE)	13	α = 0.854
Number Skills	5	α = 0.795
Number Books	2	α = 0.835
Game	2	α = 0.450
Application	4	α = 0.730
Parents Expectation of their Children's Numeracy Competency (PEN)	10	α = 0.761
Parent's Attitudes toward Mathematics (PAM)	9	α = 0.734
Early Math Competency Test*	25	KR-20 = 0.815

** The reliability coefficient is calculated using the Kuder-Richardson 20 (KR-20) formula*

From Table 6 all instruments had adequate to good internal consistency. The Home Numeracy Experience scale (α = .854) met recommendations for reliability as did Parent'' Expectation of Children' score numeracy competency (- α = .763), and Parent' Attitudes toward Mathematics scale (α = .734). Three out of four subscales for HOME made the cut for adequate reliability. Number Skills (α = .795) and Number Books (α = .835) had good reliability. The Applications subscale met the benchmark for reliability (α = .730) while Games was too low (α = .450). The Early Math Competency Test, which consisted of 25 items that were scored dichotomously (correct/incorrect), had a KR-20 of .815, showing adequate internal consistency.

Content validity was established by soliciting feedback from five experts in Curriculum and Mathematics Education majors in Addis Ababa University. Additionally, experts from Addis Ababa City Administration Education Bureau also took part in the validation of content through interviews. These experts deemed the items

appropriate for the age of the children and represented skills that children are expected to know at their age in mathematics. Three survey items were modified based on expert feedback to better capture preschool children' skills in mathematics. Having multiple experts review survey items is always ideal. These experts had special expertise in early childhood mathematics and education curriculum which supported the content validity of this instrument.

The reliability and validity analyses suggest that the present measures are psychometrically adequate. Of course, other types of validity could be established in the future. Ideally, researchers would collect longitudinal data to assess some degree of predictive validity and begin to construct a validation argument for using the EMCT across contexts. For the current study, results are divided into two parts. The first section includes psychometric data and descriptive statistics regarding participants' HNE and EMCT. The second half examines bivariate correlations and regression analyses to explain how HNE relates to children' EMCT.

Descriptive Statistics

In accordance with Table 7, Number Skills survey items were endorsed the most frequently across all items, with children being most reported to engage in counting objects (M = 3.79, SD = 0.41), printing numbers (M = 3.75, SD = 0.53), and counting down (M = 3.73, SD = 0.44). The Number Books subscale also featured highly frequent activities, with number activity books (M = 3.65, SD = 0.72) and connect- the-dot activity books (M = 3.57, SD = 0.83) being reported frequently as well.

Less frequent at-home numeracy activities/items included the application of math in everyday routines such as using calendars (M = 2.91, SD = 1.53), measuring ingredients while cooking (M = 3.31, SD = 0.97), and playing with calculators (M = 3.36, SD = 1.14). Games were endorsed least frequently across all items, with card games (M = 2.60,

SD = 1.66) and number toys being the lowest scoring activities (M = 2.90, SD = 1.39).

Table 7*: Mean and Standard Deviation of the Parent Report on Home Numeracy Experience*

Home Numeracy Activities	N	Mean	Std. Dev.
Number Skills			
Counting objects	105	3.79	.409
Sort things	105	3.65	.480
Counting down (10, 9, 8, …)	105	3.73	.444
Printing numbers	105	3.75	.533
Identify Written Numbers	105	3.62	.671
Number books			
Reading number storybooks	105	3.19	.982
Connect-the-dot activities	105	3.57	.830
Games			
Playing card games	105	2.60	1.656
Playing with number toys	105	2.90	1.393
Applications			
Having your child wear a watch	105	3.31	.974
Using calendars and dates	105	2.91	1.526
Talking about money when shopping	105	2.45	1.670
Playing with calculators	105	3.36	1.136

Note: N = 105 Number of Samples

A shown in Table 7, paired-samples t-tests revealed that counting objects was significantly more frequently reported than playing with number toys, $t(104) = 6.09$, $p < .001$, and calculators, $t(104) = 3.59$, $p < .001$. Lowest standard deviations were present in counting object/math activities and higher standard deviations were present in games and applications sub-scales. This suggests that there is homogeneity in whether families engage with young children in practicing number skills, whereas play-based mathematics skills/games and applied numeracy has more family context variability.

***Table 8**: Descriptive Statistics for Early Math Competency Test Sub-Domains (N = 105)*

Sub-domain	M	SD
Number and Operation	9.94	1.09
Algebra/Patterning	3.31	0.82
Geometry/Shape	3.45	0.77
Measurement/length, weight, capacity, time, and money	5.21	0.93

Note. Higher mean scores indicate greater competence within each sub-domain.

In Table 8, descriptive statistics were calculated for the four subscales of the early mathematics competencies test. Children were found to generally score highest in Number and Operations (Mean = 9.94, SD = 1.09). This domain had the highest mean score relative to maximum subscale score of 12, as well as above the mean of the whole sample and showed strength in identifying numbers, counting, and basic mathematical operations. Foundational numerical skills in the early years have been shown to be frequently developed through experiences in the home and school setting, as such skills are a common focus of adults when providing children with early exposure to mathematics (Purpura et al., 2017).

On the other hand, the lowest scoring domain was Algebra (Mean = 3.31, SD = 0.82). Children particularly struggled with questions involving patterning and abstract thinking to solve problems including extending a given pattern and creating their own. Skills such as these rely on exposure to algebraic activities to foster children's ability to reason in this manner (Papic et al., 2011). Children achieved immediate scores in Measurement (Mean = 5.21, SD = 0.93), however, they struggled with questions that involved iteration of units and estimating size, moving past direct comparison of two items. Skills such as these require explicit teaching around how to measure – such

as repeating units, informal and formal ways of estimating size, and practice with informal (non-standard) and formal (standard) measurement tools (Clements & Sarama, 2009).

Psychometric adequacy having been established for both instruments, and the distributions of both Home Numeracy Experience and Early Mathematics Competence having been described, the subsequent phase of analyses explores the relationships between variables of interest. Moving past simple description, these analyses address whether variance in children's home numeracy experiences correspond with variance in early mathematics competence.

Correlation Analysis

Pearson correlations between study predictors- Number Skills, Number Books, Games, and Applications), Parents' Expectations of Numeracy (PEN) - and the dependent variable (EMCT scores) were computed.

***Table 9**: Correlation between EMCT and Home Numeracy Experience Sub-scales*

Variable	1	2	3	4	5	6	7
1. Number Skill	1	.700**	.216*	.529**	-.004	.055	.535**
2. Number Book		1	.331**	.640**	-.063	-.063	.515**
3. Game Activity			1	.810**	-.130	.039	.523**
4. Application Activity				1	-.123	.065	.610**
5. Parents' Expectation					1	.480**	-.107
6. Parents' Attitude						1	-.006
7. EMCT							1

Note. Values are Pearson correlation coefficients. EMCT = Early Math Competency Test. Correlations are two-tailed. $p < .05$. $p < .01$.

As presented in Table 9, three out of four HNE sub-scales significantly positively correlated with EMCT scores. Number Skills correlated moderately with EMCT ($r = .534$, $p < .01$), Number Books also showed

a moderate positive correlation ($r = .516$, $p < .01$), while Applications was the highest correlated sub-scale with EMCT scores ($r = .612$, $p < .01$). These results suggest that higher levels of reported engagement in home numeracy activities measured by these subscales corresponded with children's higher early mathematics competence scores. The Games subscale also showed a moderate positive correlation with EMCT scores ($r = .525$, $p < .01$).

Neither PEN ($r = -.128$, $p > .05$) nor PAM ($r = .039$, $p > .05$) were significantly correlated with EMCT scores. This suggests that parental expectations and attitudes toward mathematics do not appear to have a direct relationship with children's mathematics performance on the measures used in this study. This does not conflict with previous findings that parental attitudes and expectations may affect child math skills through their impact on numeracy-related practices (Mutaf-Yıldız et al., 2020; Susperreguy et al., 2018) rather than having a direct effect.

The positive correlations between HNE subscales and EMCT support findings that frequent home numeracy activities, specifically those that were varied and incorporated applied tasks and interactive materials were linked to higher early math competence (LeFevre et al., 2009; Niklas & Schneider, 2014).

Discussion

This study aimed to explore (a) the psychometric properties and contextual validity of an adapted Home Numeracy Experience (HNE) Questionnaire and newly developed Early Math Competency Test (EMCT) and (b) parent-reported home numeracy experiences' associations with preschool children' early mathematics competence in Addis Ababa. Results are discussed below, separated by the two research questions.

RQ 1: What Are the Psychometric Properties and Contextual Validity of the Adapted HNE Questionnaire and the EMCT?

Overall, the results provide promising, yet preliminary evidence for both instruments' contextual appropriateness. Qualitative review revealed excellent content validity for the EMCT (S-CVI/Ave = .96; S-CVI/UA = .80) and acceptable content validity for the adapted HNE Questionnaire (S-CVI/Ave = .88; S-CVI/UA = .54). Taken together, these findings suggest that experts viewed EMCT items as highly relevant to expectations for mathematical learning among preschool-aged children in Ethiopia whereas most HNE items were deemed relevant but some needed additional clarity to ensure cultural appropriateness. Specifically, items received lower ratings for asking about experiences with wearing a watch and using calendars, suggesting these experiences may not generalize to equally familiar, accessible, or salient forms of home numeracy experience among all Ethiopian households.

Validity of the EMCT is critical, as early mathematics assessment should reflect the learning context's language, opportunities for learning, and curricular goals. The EMCT was explicitly developed using learning goals aligned with the Ethiopian preprimary curriculum and reviewed by early childhood experts with expertise in Ethiopia. As such, the above findings provide evidence for using the EMCT to measure foundational mathematical skills among preschool children living in Addis Ababa. However, psychometric evidence above content validity cannot fully speak to measurement validity. Additional research is needed with larger and more diverse samples before using the EMCT for decisions about students that have high stakes (e.g., screening, comparison, or policy decisions).

The exploratory factor analysis largely supported the proposed multidimensional structure of the EMCT. The extracted factors (Arithmetic and Quantitative Reasoning, Foundational Number Knowledge, and Spatial and Patterning Skills) aligned well with the

subscales and accounted for 64.32% of the variance. This result aligns with recent perspectives that view early mathematics as a multidimensional skills construct that includes domains such as knowledge of numbers and operations, spatial reasoning, and relational thinking rather than as a unidimensional skill (Clements & Sarama, 2020; Vanbecelaere et al., 2021). Additionally, the separation between foundational number skills and spatial/patterning skills aligns with some research that children's mathematical abilities in different domains may develop at distinct rates and may benefit from different forms and amounts of instructional and at-home learning experiences (Bonifacci et al., 2021; King & Purpura, 2021).

Descriptive statistics provided further evidence of this multidimensionality. Children's overall performance was strongest in number/operations and geometry/shape but lower in algebra/patterning and measurement. This pattern could stem from higher exposure to counting, number identification, sorting, and simple operations in home and educational settings. In contrast, regular opportunities to reason about relations and sequences (as patterning does), units and transformation (geometry), and comparison, estimation, and cardinality (measurement) may require more deliberate teaching or experience. Everyday interactions may not systematically expose children to these concepts. That said, this speculation is consistent with research suggesting that children's early mathematics benefit when they engage with a variety of activities that promote higher-level applied math skills rather than spending all of their time counting or identifying numerals (Clements & Sarama, 2020; Elliott et al., 2023).

Additionally, the EMCT showed good internal consistency (KR-20 = .815), meaning its items appear to work together consistently as a measure of early mathematics ability for this population. The factor structure, content-validity evidence, and reliability estimate provide preliminary evidence that the EMCT is a promising and culturally relevant tool for assessing early mathematics skills. Nevertheless,

results should be interpreted with caution due to the small sample size and participants being recruited from a single preschool. Future studies should aim to replicate factor structure using confirmatory factor analyses, conduct item-level evaluations of difficulty and discrimination using item-response theory, and assess measurement invariance across child gender, language background, type of school, and household socioeconomic status.

Results regarding the adapted HNE Questionnaire psychometric properties were more nuanced. While the full HNE scale showed good internal consistency (α = .854) and three of four subscales demonstrated acceptable reliability, the Games subscale was not reliable (α = .450). Additionally, the EFA did not completely reproduce the HNE Questionnaire's original factor structure of Number Skills, Number Books, Number Games, and Number Applications. Instead, several items from different theoretical domains clustered into a broad direct home numeracy activity factor, while book- and game-related items formed small mixed factors. This finding suggests that Ethiopian parents may not distinguish home numeracy activities in the same way as the original HNE model. Rather, counting, number writing, books, games, and practical applications may be experienced as overlapping aspects of everyday support for children's learning. Such divergence is plausible when an instrument developed in one sociocultural setting is adapted for use in another, because the meaning, availability, and routine use of learning materials and activities may differ across households and communities (Pan et al., 2023; Vanbecelaere et al., 2021).

Recent scholarship also indicates that the home mathematics environment is not a fixed or universally structured construct. The frequency, type, quality, and developmental relevance of home mathematical activities vary substantially across families and cultural contexts (Daucourt et al., 2021; Elliott et al., 2023). Therefore, the present findings caution against assuming that theoretically defined HNE subscales can be transferred directly across settings without local

validation. At this stage, the overall HNE score appears more defensible than the individual subscale scores, whereas findings involving specific HNE dimensions should be interpreted as preliminary.

The low reliability of the Games subscale may have several explanations. First, card games and number toys may not adequately represent culturally common forms of mathematical play in Ethiopian households. Second, the two-item subscale may have been too narrow to capture the diversity of play-based numeracy activities. Third, parents may have interpreted game-related activities differently, resulting in inconsistent responses. This finding is consistent with recent evidence that measures of the home mathematics environment often require cultural adaptation and refinement to capture locally meaningful activities accurately (Daucourt et al., 2021; James-Brabham et al., 2025). Future studies should use qualitative interviews and cognitive testing with Ethiopian parents to identify locally meaningful play-based numeracy practices, including traditional games, market play, household sorting, sharing activities, and informal counting routines. A revised questionnaire should include at least three conceptually coherent items per proposed sub-scale and should be evaluated in a larger independent sample.

RQ 2: To What Extent Are Dimensions of Home Numeracy Experience Associated with Preschool Children's Early Mathematics Competence?

The second research question examined whether parent-reported home numeracy experiences were associated with children's EMCT performance. The results showed positive correlations between children's early mathematics competence and Number Skills (r = .535), Number Books (r = .515), Games (r = .523), and Applications (r = .610). Among these dimensions, Applications showed the strongest association with EMCT performance. These findings suggest that

children whose parents reported more frequent numeracy-related interactions at home tended to obtain higher scores on the EMCT.

The positive association between applied numeracy activities and EMCT scores is particularly notable. Activities such as discussing money while shopping, using calendars and dates, talking about time, and using calculators may help children connect mathematical symbols and procedures with meaningful everyday situations. Such experiences can make mathematical ideas more concrete and may encourage children to use number, comparison, and problem-solving skills beyond formal classroom tasks. This interpretation is consistent with recent research showing that home numeracy activities may be especially beneficial when they involve meaningful parent–child interaction, mathematical language, and opportunities to connect abstract concepts with everyday experiences (Elliott et al., 2023; King & Purpura, 2021).

The positive association between Number Skills activities and EMCT performance also supports the importance of direct numeracy interactions. Counting objects, sorting, counting backward, identifying numerals, and writing numbers may strengthen foundational number knowledge, which was one of the most clearly defined domains in the EMCT factor analysis. Similarly, the association between Number Books activities and children's mathematics competence suggests that numeracy-related books and connect-the-dot activities may support mathematical vocabulary, symbolic understanding, attention to numerical representations, and parent–child discussion about quantity and number. This finding agrees with evidence that direct numeracy activities and mathematical language are related to young children's early mathematics skills (King & Purpura, 2021).

The Games sub-scale was also positively correlated with EMCT scores. However, this result should be interpreted with caution because the Games subscale had low internal consistency and did not emerge as a stable independent factor in the exploratory analysis. The positive correlation may indicate that playful numeracy experiences are relevant

to children's mathematical development, but it may also reflect broader family differences in access to learning materials, parental involvement, or children's prior mathematical interest. Thus, the present study cannot determine whether game-based activities independently contribute to children's mathematics competence.

The overall pattern of positive associations is consistent with recent reviews indicating that home mathematical activities are related to children's early mathematics skills. However, the correlations observed in the present study were larger than the small average association reported in recent meta-analytic evidence. Daucourt et al. (2021) found a small positive association between the broader home mathematics environment and children's mathematics achievement. Similarly, James-Brabham et al. (2025) reported a small overall association between the frequency of home mathematical activities and children's mathematical skills, with substantial variability across studies. Their review further showed that higher risk of bias was associated with larger effect sizes. Therefore, although the present findings support a positive association between home numeracy experiences and early mathematics competence, the magnitude of these relationships should be interpreted cautiously.

Several methodological features may explain why the correlations in the present study were comparatively large. The study used a cross-sectional design, parent-report measures of home numeracy activities, and a sample drawn from one private preschool. These features may increase observed associations because of shared-method influences, restricted contextual variation, or the possibility that parents of children with stronger mathematical skills engage more frequently in numeracy activities. In addition, children's mathematical competence may influence the types and frequency of activities parents choose to provide. Consequently, the results do not establish that home numeracy activities caused higher mathematics performance.

Parents' expectations of children's numeracy competence and parents' attitudes toward mathematics were not significantly associated with EMCT scores. This finding suggests that parental beliefs alone may not have a direct relationship with children's mathematics performance in this sample. One possible explanation is that beliefs influence children's learning indirectly through the activities, language, encouragement, and learning opportunities that parents provide. Another explanation is that the adapted measures may not have fully captured culturally specific forms of parental expectations and attitudes. The absence of direct associations should therefore not be interpreted as evidence that parental beliefs are unimportant. Rather, it suggests that the pathway from beliefs to children's outcomes may be indirect, context dependent, or more complex than can be captured through bivariate correlations.

This interpretation is consistent with evidence that the home mathematics environment includes multiple interconnected components, including parent beliefs, attitudes, mathematical talk, resources, and activities (Daucourt et al., 2021; Vanbecelaere et al., 2021). Recent evidence also indicates considerable heterogeneity in the association between home mathematical activities and child outcomes across studies, suggesting that contextual factors, measurement quality, and the nature of parent–child interactions may shape these relationships (James-Brabham et al., 2025). Accordingly, parent-support interventions should not focus solely on changing parental attitudes; they should also help parents translate positive beliefs into feasible, developmentally appropriate, and culturally meaningful numeracy interactions.

Overall, the findings support the view that the home environment is an important context for early mathematical learning. In this sample, practical and interactive home numeracy experiences were associated with stronger early mathematics competence. Nevertheless, because the study was cross-sectional and correlational, the direction of influence cannot be determined. Children with stronger mathematical

skills may elicit more numeracy activities from parents, or both home numeracy experiences and child performance may be influenced by parental education, family income, school quality, and access to learning resources. Longitudinal and intervention studies are therefore needed to clarify these pathways.

Conclusion

The current study provided preliminary psychometric evidence of the contextual fit of an adapted Home Numeracy Experience (HNE) Questionnaire and newly developed Early Math Competency Test (EMCT) among preschool-aged children in Addis Ababa, Ethiopia. The EMCT possessed excellent content validity, a theoretically interpretable 3-factor structure, and good internal consistency. The adapted HNE Questionnaire had acceptable content validity and good internal consistency overall; however, its proposed 4 subscale structure was not replicated, and its Games subscale had poor internal consistency. Caution should be used when drawing conclusions from the individual dimensions of the HNE; however, the total score may serve as a rough indicator of parent-reported home numeracy engagement. Children's early mathematics competence was positively associated with parent-reported home numeracy activities. Parent-report of applying mathematics to daily tasks showed the largest association with children's EMCT scores, followed by number skills, games, and number-book activities. Although not causal, these findings underscore those opportunities to count, sort, talk about money, use calendars or clocks, read books, and engage in math-related games may offer authentic opportunities to learn mathematics. Parents' expectations or attitudes about math were not significantly associated with children's EMCT scores. This pattern of findings may indicate that parents' beliefs indirectly affect children's mathematical competence through their decisions about how often and in what ways to engage children in mathematical thinking. This study has implications for early childhood education practice and research in Ethiopia. Parents/caregivers may

benefit from guidance on how to embed mathematics in daily routines; however, preschool teachers should emphasize patterning and measurement, on which children scored comparatively lower. Future research should continue to refine the HNE Questionnaire with Ethiopian families using qualitative methods and evaluate both the HNE Questionnaire and EMCT using larger samples, CFA, item-response modeling, and measurement-invariance testing to assess psychometric strengths and weaknesses. Longitudinal studies and math-focused home numeracy interventions are needed to determine whether and how changes in home numeracy impact child math outcomes over time.

Limitation

Although forward translated, reviewed by experts, and revised prior to data collection, the Games sub-scale may not have included items that are representative of numeracy practices during play in Ethiopian households. Indicator- and item-level analyses suggested adequate internal consistency and little variability in how parents responded to several game-related items; however, the EFA did not fully support the hypothesized 4 subscale structure of the instrument. Two factors were represented by only two items, and one item cross-loaded on two factors. Results involving this subscale and the individual dimensions of the HNE should be considered preliminary and interpreted with caution. We recommend that future research revises this instrument using culturally grounded methods (e.g., qualitative item elicitation, cognitive interviews, and pilot testing) and conducts a rigorous psychometric evaluation using CFA, item response modeling, differential item functioning, and measurement-invariance testing to evaluate the factor structure and dimensionality of the HNE across Ethiopian linguistic and regional groups.

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Appendix-A

Table: Item-Level Content Validity Index (I-CVI) of Early Math Competency Test Items

Item No.	Test Item	I-CVI
1	Can you count to 20 for me?	1.00
2	Can you count backward from 10 to 1?	0.80
3	Please count to 15 starting at 4	1.00
4	Can you point to the number 7 on this page?	1.00
5	What number is this? (Show numeral 12)	1.00
6	Which one has more? (4 dots vs. 3 dots)	1.00
7	Which number is smaller, 12 or 13?	1.00
8	Put these numbers in order from largest to smallest (11–20)	0.80
9	How much is 2 + 7?	1.00
10	If you have 3 bananas and get 2 more, how many do you have?	0.80
11	7 birds on a tree, 2 fly away — how many left?	1.00
12	Continue this pattern: Red, Yellow, Green, Red, ____	1.00
13	Find the missing shape in this pattern (circle, circle, triangle, __, square, square)	1.00
14	What number comes before 15?	0.80
15	What number comes next: 14, 15, 16, ____	1.00
16	Name these shapes (circle, square, triangle, rectangle)	1.00
17	Which of these shapes is different?	1.00
18	Which shape has two parallel sides?	0.80
19	Show me all shapes with four equal sides	1.00
20	Show me the shorter stick	1.00
21	Which is heavier: feather or ball?	1.00
22	Which cup can hold more water?	1.00
23	What time is lunchtime?	1.00
24	How many days are there in a week?	1.00
25	If one toy costs 5 Birr, how much for two toys?	0.80

Note: S-CVI/Ave = 0.96 **|** *S-CVI/UA = 0.80*

Appendix-B

Table: Content Validity Indices for the Home Numeracy Experience Survey

No.	Home Numeracy Experience Survey Item	Number of Agreement	I-CVI
1	Counting Objects	5	1
2	Sort Things	5	1
3	Counting Down (10, 9, 8, …)	5	1
4	Printing Numbers	5	1
5	Identify Written Numbers	5	1
6	Reading Number Storybooks	4	0.8
7	Connect-the-Dot Activities	5	1
8	Playing Card Games	4	0.8
9	Playing with Number Toys	4	0.8
10	Having Your Child Wear a Watch	3	0.6
11	Using Calendars and Dates	3	0.6
12	Talking About Money When Shopping	4	0.8
13	Playing with Calculators	5	1

Note: S-CVI/Ave = 0.88 **|** *S-CVI/UA = 0.54*