

# The Home Mathematics Environment of Dual-Language Learner Children and Their Early Mathematics Skills

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## Introduction and Goal of the Study

- Early math abilities have been found to be a strong predictor of later academic achievement (Clements & Sarama, 2011)
- Home mathematics environment (HME) can foster children’s math skills (e.g., del Río et al., 2017; Lefevre et al., 2002; Napoli & Purpura, 2018)
- Research exploring the association between HME and children’s math outcomes has tended to study English monolingual children even though:
  - dual-language learner (DLL) children are the ones who often underperform in mathematics (Galindo & Fuller, 2010; Garcia & Miller, 2008)
  - DLL student population, has grown by 24 percentage points since 2000, representing one third of all children aged 8 and under (Park et al., 2018)
- For parents of Latinx DLL children, the home environment is in tension between the influences of the local context and their own culture:
  - Latinx parents use to see home and school as two separate contexts for learning (Suárez-Orozco et al., 2009)
  - they are usually asked to adapt and align their practices and home activities to those expected by the U.S. educational system (Melzi et al., 2018)
- The goal of this study is to examine the association between the HME and early math skills among Latinx children, taking into consideration language skills

## Research Questions

RQ1: Is the construct of the HME latent variable similar between the three groups?

RQ2: To what extent is the HME of both groups of Latinx DLL children associated with their early math performance, above and beyond vocabulary skills?

RQ3: To what extent is the HME associated with children’s early math performance, comparing both groups of Latinx DLL children to their monolingual peers?

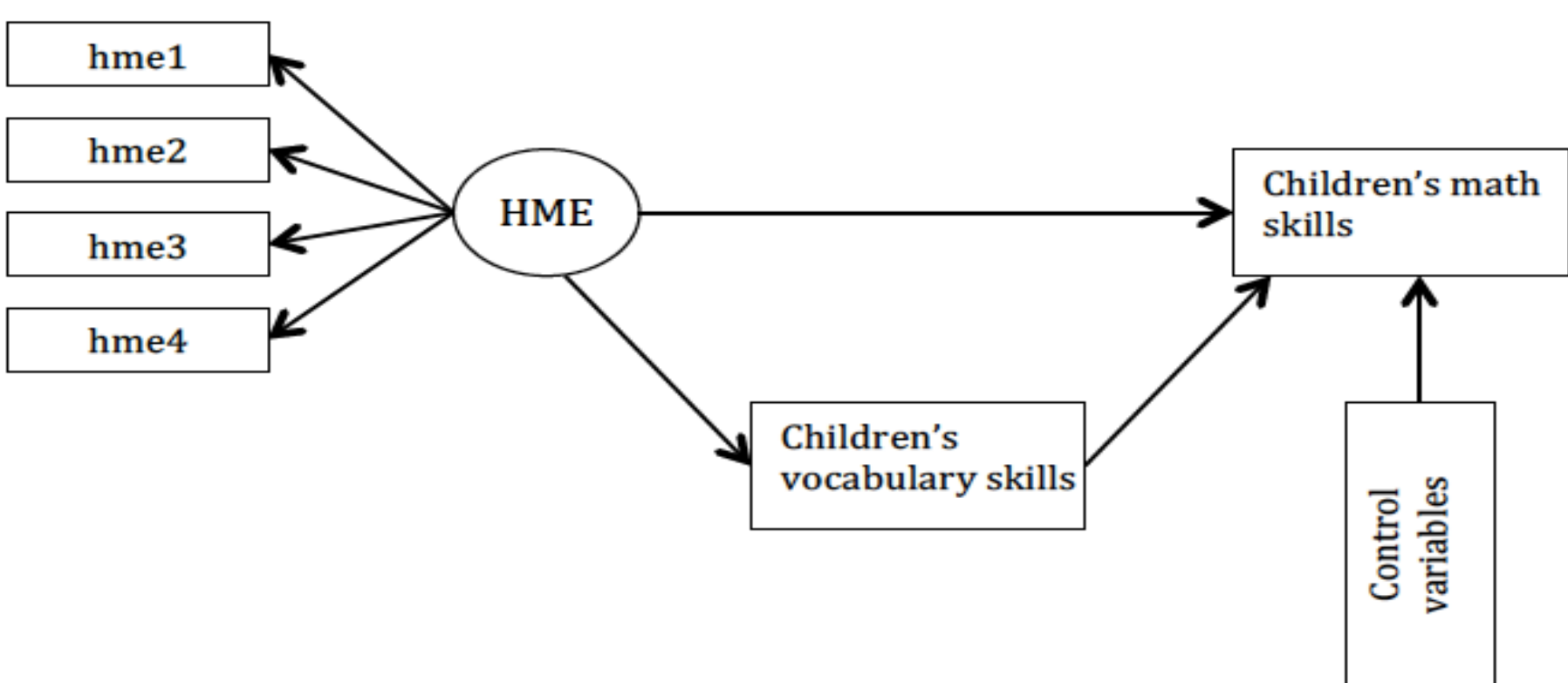
## Method

- Data: Head Start Family and Child Experiences Survey (FACES) cohort spring 2014-fall 2015
- Sample: 1,487 children whose home language was either **English** or **Spanish** and whose parents responded to the parents’ survey
  - Children age in months  $M = 48.41$  ( $SD = 6.84$ )
- We categorized children into three groups based on their home language and their scores on the language screener test:
  - (a) English monolingual, children who speak English at home ( $n = 949$ )
  - (b) DLLs fluent in English, children who spoke Spanish at home and passed the language screener test ( $n = 346$ )
  - (c) DLLs not-yet-fluent in English, children who spoke Spanish at home and did not pass the language screener test ( $n = 192$ )
- Multi-group SEM was used for the analyzes

### Measures

- Early Mathematics Skills (time 2,  $\alpha = .92$ )
  - Woodcock–Johnson III Applied Problems
  - ECLS-B Mathematics
- Home Mathematics Environment (time 1,  $\alpha = .62$ )
  - (a) played counting games like singing songs with numbers or reading a book with numbers
  - (b) played a board game or a card game
  - (c) played with blocks
  - (d) counted different things
- Children’s Vocabulary (time 2,  $\alpha = .97$ )
  - Peabody Picture Vocabulary Test-Fourth Edition (PPVT-IV)
- Control Variables: child’s age, gender, whether children had attended any childcare before or after Head Start, mother’s highest education, family income, and classroom quality indicators, children’s math skill time 1

**Figure 1**  
Conceptual Model Diagram



## Results

**Descriptive:** Group difference in mean – ANOVA

- English monolingual children performed higher in math than their Latinx DLL peers → Statistically significant difference between English monolingual children and DLLs not-yet-fluent in English
- Parents of English monolingual children reported doing more home mathematics activities with their children than parents of either Latinx DLL group → This difference was significant between the English monolingual group and the DLL not-yet-fluent in English group

**RQ1:** Group invariance

- Invariance of the HME factor structure among the three groups was achieved: RMSEA = .042 with 95% CI [.011, .068]; CFI = .948; TLI = .922
- Wald Test = 3.647 ( $df = 6$ ) ,  $p = .724$ 
  - Differences in the factor loading of the four indicators were not statistically significant suggesting that all four items were related in a similar way to the latent variable HME for the 3 groups
  - Thus, loading factors were constrained to be equal across groups for RQ2 & RQ3

**RQ2 & RQ3:** HME association with early math’ skills above and beyond children’s vocabulary skills for each group

- The three group model has an excellent fit to the data  
 $\chi^2(144) = 169.11$ ,  $p = .074$ , RMSEA = .02, CFI = .97, and TLI = .96
- Results are present in Table 1

**Table 1**

*Directs and Indirect Effects of HME on Children’s Mathematics Skills for Each Group*

	English monolingual $\beta$ (SE)	DLL fluent in English $\beta$ (SE)	DLL not-yet-fluent in English $\beta$ (SE)
The effect of HME on mathematics skills	0.06* (.03)	0.05 (.05)	-0.07 (.10)
The effect of HME on vocabulary	-0.03 (.05)	0.05 (.07)	0.17 (.17)
The effect of vocabulary on mathematics skills	0.20** (.03)	0.16** (.03)	0.16* (.06)
Indirect effect	-0.01 (.01)	0.01 (.01)	0.03 (.02)
Total effect	0.05 (.03)	0.06 (.05)	-0.05 (.10)

*Note.* Standardized results are presented. Standard errors are presented in parentheses. HME = home mathematics environment. Model includes all control variables. \* $p < .05$ . \*\* $p < .001$

- Latinx DLL groups:**
  - No evidence of an association in the direct effect between HME and children’s math performance
  - No significant mediator effect of children’s vocabulary skills
    - Not significant association between HME and children’s vocabulary
    - But a significant association between children’s vocabulary skills and math performance was found
- English monolingual group:**
  - Statistically significant association between HME and children’s math skills
  - No significant mediator effect of children’s vocabulary skills
    - Not significant association between HME and children’s vocabulary skills
    - Significant association between children’s vocabulary skills and math performance

## Discussion & Conclusion

- English monolingual children benefit from the mathematics-related activities that parents do with them at home. However, this association was not found to be significant for neither of the Latinx DLL groups
- Although the four items used to capture the HME did not function differently across the groups, there was a significant mean difference in the ANOVA results between HME for English monolingual and DLL not-yet-fluent in English children
- Latinx families could be engaging in other mathematics activities with their children that were not captured by the items
  - We do not yet know how to measure the uniqueness of home mathematics experiences among Latinx families
  - There is limited research about the mathematical activities that Latinx parents engage in at home with their children
  - Additional mixed-method research is needed to fully capture home experiences and differences in cultural environments
- These findings shed light on the need for identifying cultural variance in the HME of Latinx and English-monolingual families and its association with children’s early mathematics performance