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REPORT

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Parents' views and experiences of the home mathematics environment: A cross-country study

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Abstract

The purpose of the current study was to qualitatively explore the home mathematical environment across two regions in two different countries (i.e., Cuba and Mexico), replicating a qualitative study previously conducted in Northern Ireland (NI), United Kingdom (Cahoon et al., 2017). Semi-structured interviews with parents/caregivers of children (3- to 5-year-olds) in both Mexico ($n = 13$) and Cuba ($n = 40$) were completed to investigate their views, experiences and attitudes towards the home mathematical environment. Thematic analysis was used to explore themes relevant to the home mathematical environment. Three consistent themes were found in the Mexican and Cuban data: Numeracy Environment Structure, Expectations and Attitudes and Views of Technology. Two unique themes were found in the Mexico data: Interactions Related to Reading or Mathematics, and Child's Attitudes in Relation to Mathematics. One unique theme was found in the Cuban interviews: Interactions for Learning. Although diverse themes were identified, consistencies were also observed. This suggests that some home numeracy practices may be universal in nature. This research increases the understanding of human development in context.

KEYWORDS
cross-country, expectations and attitudes, home mathematics environment, numeracy teaching, qualitative, technology

1 | INTRODUCTION

1.1 | Background

Early mathematical skills predict later educational achievement, employment opportunities and broader health outcomes (Davis-Kean et al., 2022; Duncan et al., 2007; Williams, 2003). Some research suggests that school-entry mathematical skills are better predictors for later academic achievement in mathematics, reading and science than reading skills at school entry (Claessens & Engel, 2013; Napoli & Purpura, 2018). Furthermore, family contexts, not schools, have been identified as a major source of inequality in student performance (Butterworth, 2005). Yet, research on early mathematical experiences outside of the school context is only beginning to expand (e.g., Chernyak, 2020; Hart et al., 2016; Skwarchuk et al., 2014; Purpura et al., 2021) with most of the mathematical development research having focused on cognitive aspects of development (Cragg & Gilmore, 2014; LeFevre et al., 2010; Zhang et al., 2014) or school interventions (Arnold et al., 2002; Clements & Sarama, 2008; Cohrssen & Niklas, 2019). Attention has now turned to the influence of the home mathematics environment (HME) on the development of individual competencies (i.e., mathematical abilities such as ordering, cardinality etc.; Anders et al., 2012; LeFevre et al., 2010).

1.2 | Defining the home mathematics environment

The HME has been conceptualised in several different ways. In Canada, LeFevre et al. (2009) developed a model that recognised the occurrence of indirect activities (such as cooking, playing board games) and direct activities (such as counting, teaching digit recognition, printing numbers) that contributed to the overall HME. LeFevre et al. (2009) established that parent reports of the frequency of direct and indirect numeracy activities in the home were positively related to the mathematical skills of children in Kindergarten, Grade 1 and Grade 2 (mean age: 5:11 (years: months), 6:9, and 7:9, respectively). In Canada, a formalised Home Numeracy Model (Skwarchuk et al., 2014) aligned indirect/informal activities and direct/formal activities and identified differential pathways in development. Informal activities refer to activities that occur spontaneously within the home environment and indirectly provide opportunities for learning about numeracy (e.g., play with building blocks, sharing out sweets)—the goal of these activities is *not* about learning mathematics but rather broader learning and stimulation. In contrast, formal activities focus on engaging children in learning purposefully about mathematics (e.g., practicing basic arithmetic; Skwarchuk et al., 2014). These differential pathways in development specify that informal mathematics exposure promotes non-symbolic mathematics skills, whereas formal practices support the development of symbolic mathematics knowledge (Skwarchuk et al., 2014). In addition, some studies have differentiated HME between the occurrence of basic and advanced activities in Belgium and Chile (e.g., Mutaf-Yıldız et al., 2020; Susperreguy, Di Lonardo Burr, et al., 2020). Depending on age, basic activities for young children (in this context 5–6-year-olds) are defined as simple number practices, such as counting and number identification and advanced practices are defined as more complex mathematical processes, such as addition (Mutaf-Yıldız et al., 2020). A consistent finding is that developmentally appropriate advanced practices, rather than basic practices, are associated with children's mathematics skills (Mutaf-Yıldız et al., 2020; Thompson et al., 2017).

Even though there are clear inconsistencies in the conceptualisation and definitions of the HME, a recent systematic review and meta-analysis (including 51 studies) suggests that, overall, the HME has a small, but positive relation with mathematical skills ($r = 0.14$; Daucourt et al., 2020). However, there is some variation across studies, with some establishing a positive relationship (LeFevre et al., 2010; Manolitsis et al., 2013; Niklas et al., 2016; Niklas & Schneider, 2014), mixed findings within the same study (LeFevre et al., 2009; Ramani et al., 2015; Skwarchuk, 2009; Zippert & Ramani, 2017) or null results (Blevins-Knabe et al., 2000; Missall et al., 2015). These inconsistent findings may arise because of a multitude of factors, such as the age of the participants within individual studies, the use of different measures of the HME, selected outcome measures and between country differences (Elliott & Bachman, 2018).

1.3 | Home mathematics environment in context

According to Bronfenbrenner's Bioecological model, children's home environments are situated within cultural contexts that have both direct and indirect impacts on their development (Bronfenbrenner, 1976; Bronfenbrenner & Morris, 2007). Within Bronfenbrenner's model, culture is positioned in the macrosystem, only exerting an indirect effect on children's development. However, Vélez-Agosto et al. (2017) proposed an updated framing of this model with culture embedded within the microsystem level, thus having a direct and substantive influence on child development. Although there is a long history of respecting that family interactions occur within differential cultural contexts (Coll et al., 1996) research taking this approach is underdeveloped, especially concerning the HME (Hornburg et al., 2021). Research suggests that parent expectations and attitudes towards mathematics and their practices may differ dramatically across cultures and are likely to reflect specific cultural norms (Phillipson & Phillipson, 2007). A recent international position paper, involving 33 experts from 13 countries, identified the need to deeply consider diverse cultural factors concerning the HME (Hornburg et al., 2021). Key questions were considered in this paper, such as can the concept of the HME be described as "universal"? and what is the potential influence of cultural norms on parent–child activities? In addition, the position paper clearly highlighted the importance of understanding the HME from a qualitative perspective. Taking this approach will ensure that any future quantitative measurement developments reflect specific culturally dependent attitudes, expectations and activities. In addition, mixed-methods approaches can ensure that culturally specific nuances that may drive subtle differences in quantitative responses can be fully explored.

The current understanding of the HME is dominated by research in the United States (e.g., Blevins-Knabe & Musun-Miller, 1996; Thompson et al., 2017), Canada (e.g., LeFevre et al., 2009; Skwarchuk et al., 2014) and Europe (e.g., Germany: Niklas & Schneider, 2014; Belgium: Mutaf-Yıldız et al., 2020). In contrast, relatively little is known about the HME in non-European or non-North American countries. However, there is an emerging body of evidence on the HME from China (Wei et al., 2020), Chile (Susperreguy, Di Lonardo Burr, et al., 2020; Susperreguy, Douglas, Xu, Molina-Rojas, & LeFevre, 2020) and Mexico (Susperreguy et al., 2021), but these data have been collected with tools developed in North American and European countries and directly applied to these different cultural contexts. This is not a unique issue for HME research but has been identified as a barrier to understanding human development more broadly due to the reliance on samples previously referred to as WEIRD (i.e., Western, Educated, Industrialized, Rich, Democratic, Henrich et al., 2010). Increasingly, this division is referred to as Majority World versus Minority World, attempting to address bias even within the WEIRD acronym, with criticism suggesting that this term is "Western-biased". This terminology also recognises where the majority of the world's population lives, whose populations are significantly underrepresented in current research (Draper et al., 2022). Although this initial approach of applying tools developed in Minority countries to Majority countries has provided some insight into the HME outside North America and Europe, it becomes a challenge when attempting to generalise research findings or understanding universality of concepts, such as the HME, as populations can vary considerably in the extent to which they display certain biases and preferences (Henrich et al., 2010). Generalising findings across diverse samples may be problematic due to multiple factors, for example, certain types of skills may be differentially prioritised in some countries.

1.4 | Measuring the home mathematics environment

The HME has been predominantly measured through quantitative survey methodologies focusing on questions, mainly generated in Canada and the United States, on the frequency of home numeracy activities that parents and children engage in (e.g., Kleemans et al., 2012; LeFevre et al., 2009; Melhuish et al., 2008). In addition, questionnaires have been used to measure caregivers' broader attitudes and beliefs (e.g., mathematical anxiety) about mathematics that have also been reported to be components of the HME (Geist, 2015). There is a growing body of literature derived from samples in Latin America. Questionnaire-based studies on the relation between the HME and children's mathematics skills (Becerra Orellana, 2016; mean age of children 63 months) and intervention studies (de León, 2016; mean age of children 73 months) in Latin American countries have observed positive relationships, albeit weaker than those with generally North American or European samples (e.g., Susperreguy et al., 2021; age range of children 35 to 76 months). For example, research in Chile has indicated that there is a positive, weak relationship between the HME (i.e., operational activities and shared number-game play) and mathematical skills (both $r = 0.15$; Susperrreguy et al., 2020; mean age at the end of prekindergarten 4 years 7 months and at the end of kindergarten 5 years 10 months). Furthermore, Leyva (2019) examined how Chilean parents supported their children's writing and mathematics during a grocery game through observations. They examined whether parent's support predicted children's academic skills across pre-kindergarten (mean age 53 months) and found that parents displayed moderate levels of mathematical support in the grocery game and their mathematical support uniquely predicted gains in children's maths skills. Findings from research in Mexico are complex, with positive relationships between "advanced" aspects of the HME (e.g., helping the child to learn simple sums, encouraging the child to perform mental operations, weigh, measure and compare quantities) and mathematical skills for families from high-SES backgrounds, but this relation was not observed for families from low-SES backgrounds (Susperreguy et al., 2021). However, these weaker associations may represent either genuine differential relationships between the HME and mathematical skills across cultural contexts or suggest issues with the application of questionnaires developed in one cultural context being directly used internationally.

There are multiple reasons why the application of tools generated in different cultural contexts may not be valid. For example, different activities may not occur in different family contexts, different caregivers may be involved in children's lives in different countries and beliefs and attitudes about mathematics vary across countries (Hornburg et al., 2021). Recently, there have been some cross-cultural adaptions of HME measures (i.e., Susperreguy et al., 2022; Susperreguy, Douglas, et al., 2020). Susperreguy, Douglas, et al (2020) investigated the HME in Chile and made minor linguistic adaptations to the popular Skwarchuk et al. (2014) questionnaire to be suitable for use by Spanish speakers. The same translated questionnaire was used to compare the HME in Canada, Mexico and Chile in a subsequent paper (Susperreguy et al., 2022). These studies highlight the need to develop models of the HME that are culturally sensitive and show the complexities of comparing home learning environments across countries, especially in the absence of culturally sensitive tools. To understand the HME in different contexts, qualitative research is required to form the basis of the development of appropriate measurements.

Qualitative approaches are not commonly used in HME research and have only been used in Minority country settings (for example, Beltrán-Grimm, 2022; Cahoon et al., 2017). Beltrán-Grimm (2022) investigated the informal contextual factors of Latina mothers in the United States with their 3- to 5-year-olds, showing that these mothers participated in different numeracy environments that were formed by their own culturally informed understanding of knowledge which subsequently could impact their children's educational experiences. Qualitative research by Cahoon et al. (2017) explored the nature of the HME for 3- to 5-year-old children in Northern Ireland (NI), United Kingdom using semi-structured interviews with eight parents. The questions used to interview the parents/

caregivers were developed using content from previously used HME-related questionnaires (e.g., a question was asked about the frequency and structure of mathematical activities in comparison to reading in the home taken from Early et al., 2010). Questions were used flexibly to generate statements from parents/caregivers, which provide insight into behaviour relevant to the HME, how parents/caregivers might teach their children numeracy skills, and under what circumstances. Activities that had rarely been measured in HME research emerged from the interviews, such as the use of portable tablet devices and viewing educational television programmes emphasising the importance of qualitative research with parents/caregivers of young children. The data from the semi-structured interviews (i.e., Cahoon et al., 2017) were analysed using thematic analysis and six themes were identified (see Figure 1). The definitions of these six themes have been provided (see Supplementary Material A, Table 1).

Galindo et al. (2019) used a mixed-methods approach to understand immigrant Latinx mothers' (living in the United States with preschool through first-grade children) conceptualisation of mathematics and their beliefs and practices around children's mathematical skills in the home environment. Results indicated that mothers defined mathematics along school-based or formal definitions and also suggested low awareness regarding the spontaneous and informal aspects of mathematics. This formal approach was also reflected in parent approaches to learning, in which mother's reported reliance on direct instruction. In contradiction to past quantitative research with Latinx families (Valencia & Black, 2002), mothers indicated active engagement in education at home with their children and between siblings.

More broadly, studies within the United States have identified that a positive affect towards mathematics is a predictor of engagement in maths activities at home (Maloney et al., 2015). This study highlighted that 50% of

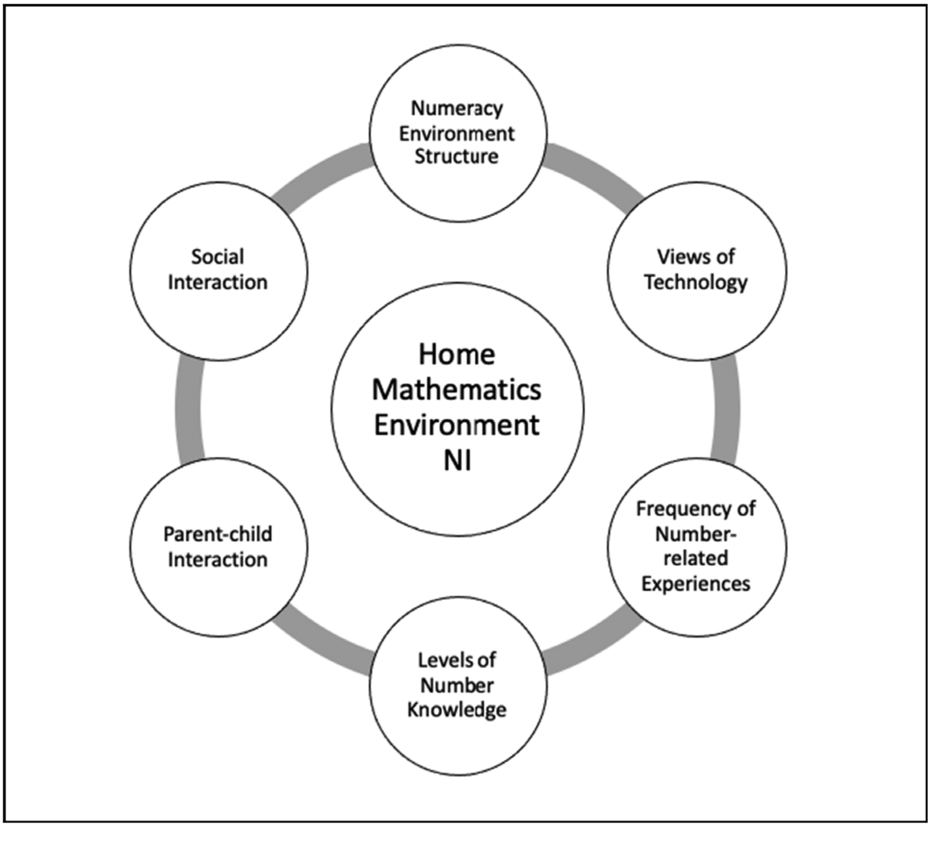

FIGURE 1 The six themes from Cahoon et al. (2017).

mother's enjoyed mathematical activities, concluding that promoting mother's positive attitudes towards mathematics may be a vehicle to improve engagement in home maths activities and children's subsequent learning. Although this paper makes advances in diversifying the viewpoint of HME by sampling a minority group within the United States, there is a lack of similar knowledge from Latinx samples who are living in Latin American countries.

Qualitative research on Mexican parental attitudes and beliefs around home literacy and language development indicated some contrasting findings with research conducted with Mexican American families (i.e., Galindo et al., 2019; Melzi et al., 2022; Mendelsohn et al., 2023). Specifically, Mexican parents recognised a balance of responsibility for children's education between the home and school setting. Parents in this study also emphasised the importance of early exposure to reading material for literacy success and were able to identify activities (such as, joint language play) that would stimulate learning. Parents had high expectations for their children's reading skills, but also emphasised social and moral competencies as important outcomes for their children (Gonzalez et al., 2018). Qualitative research has also focused on mathematical language in Hispanic/Latine families. Melzi et al. (2022) and Mendelsohn et al. (2023) both investigated Hispanic/Latine mothers'/caregivers' mathematical language (i.e., spatial and/or number). Mathematical language use varied substantially between mothers, and their quantity of mathematical language was related to children's own mathematics talk (Mendelsohn et al., 2023). Melzi et al. (2022) established that although spatial language, rather than mathematical language, was most commonly occurring during instructions with children, mathematical language, but not spatial language, was related to children's own mathematical language use. These data give insight into the nature of the Home Literacy Environment (HLE; i.e., parents helping their children to read words and the frequency of shared reading) and a component of the HME for Latine caregivers and Hispanic mothers in the United States. However, similar data do not exist for the HME in Mexico or other Latin American countries.

1.5 | The current study

Underpinned by Bronfenbrenner's Bioecological model (Bronfenbrenner, 1976; Bronfenbrenner & Morris, 2007) and the updated framing of this model by Vélez-Agosto et al. (2017), the current study aims to further explore an environmental context in which children explore and learn about mathematics and interact with their parents/caregivers. Cross-country research is notoriously complex due to the uncontrollable nature of differences across countries, such as language, gross domestic product (GDP) and cultural norms (Cankaya & LeFevre, 2016; Hunt et al., 2021). The purpose of the current study is to replicate a qualitative study conducted by Cahoon et al. (2017) in NI, to understand the similarities and differences of home mathematical contexts across three countries (i.e., NI, Cuba and Mexico), respecting that these parent–child interactions may be culturally diverse (García Coll et al., 1996) and that this diversity may be related to child development (Vélez-Agosto et al., 2017). Cahoon et al. (2017) identified six themes: Numeracy Environment Structure, Frequency of Number-related Experiences, Levels of Number Knowledge, Views of Technology, Parent–child Interaction and Social Interaction (see Supplementary Material A, Table 1). These qualitative data and analyses are also fundamentally important for future research to ensure that self-report measures of the HME are appropriate for use in different country contexts (Hornburg et al., 2021). Qualitative approaches are a necessary step to enable face validity in future amended or developed measurement tools.

There is strong evidence that mathematics is a language-dependent skill (Purpura et al., 2021). Sites within the current study have been strategically selected to enable between country comparison whilst controlling for official language (i.e., Spanish) as there are known influences of language structure on mathematical learning (e.g., Mark & Dowker, 2015; Moeller et al., 2015). In addition, both Cuba and Mexico are recognised by the Organization for Economic Co-operation and Development (OECD) Official Development Assistance (ODA) Development Assistance Committee (DAC) countries, thus controlling for overall GDP. As already stated, we lack qualitative data on differential (or similar) cultural approaches to early mathematics learning support in the home from Mexico and Cuba. However, we do know that there are wide gaps in children and young people's outcomes in mathematics between the two countries. Cuba is reported as having the highest level of mathematical achievement in Latin American countries based on the Office for Education in Latin America and the Caribbean (OREALC) 13-country survey (Carnoy, 2007). This should be contextualised with Cuba being recognised by the OECD as an ODA DAC recipient country. In 2018, Mexico was ranked 35th out of 35 countries in mathematical achievement (Schleicher, 2019), based on the Program for International Student Assessment (PISA) study. Cuba does not participate in the PISA study that assesses student attainment at 15-years-old. According to data from the Second Regional Comparative and Explanatory Study (SERCE), third-grade students in Cuba score higher in mathematics compared with those in Mexico (proportion of students occupying Level 4 attainment: Cuba = 54.36% vs. Mexico = 15.59%; Valdés et al., 2008). Therefore, selecting these two countries offers the opportunity to examine the applicability of the HME framework in potentially diverse settings, whilst maintaining relative control over additional extraneous variables such as OECD status, mathematical achievement variation and dominant national language (for more information on comparing country contexts see Supplementary Material B).

2 | METHOD

This research was reviewed and approved by the School of Psychology, Research Ethics Committee (REC) in NI. All documents (i.e., information sheet, consent form and interview schedule) were translated from English to Spanish by a professional translator based in Mexico. The translated documents were verified by all the Spanish-speaking authors before they were presented to participants to ensure the accuracy of translation.

Inclusion criteria for participation were that the parent/caregiver was over 18 years old and the primary caregiver of at least one child aged between 3 and 5 years old. Participants provided informed consent to confirm they understood that the interviews would be recorded and transcribed verbatim. The researchers (one in Mexico and one in Cuba) arranged a suitable date and time for the interview with the participants via phone or email. Data were collected by researchers whose identities aligned with the participants in their sample and whose first language was Spanish. All participants completed a short questionnaire before the interview regarding their background information. The researchers used a list of open-ended questions that included prompts and probe questions (see supplementary materials C) based on those used in Cahoon et al. (2017). The session lasted approximately 45 min in total per participant.

During data collection, Cuba and Mexico experienced COVID-19 related lockdown restrictions. In Mexico, schools and kindergartens were closed, but remained open for children of key workers only. In Cuba, schools were closed but kindergartens remained open. However, parents/caregivers could decide whether to send their children to the educational setting or remain at home. Most parents/caregivers in Cuba kept children at home.

2.1 | Recruitment procedure: Mexico

In Mexico, local day care leaders were contacted by phone to obtain permission to distribute an information sheet and consent form electronically to parents/caregivers. Once parents/caregivers agreed to participate, the informed consent and background questionnaire link was sent electronically. After the informed consent was received a date and time was scheduled to conduct the interview by telephone. The use of electronic communications was necessary due to COVID-19 guidance from the local government and the host university. No incentives were offered to the participants in either country.

2.2 | Recruitment procedure: Cuba

To recruit participants at their day care centres, the consent of the National Director for Early Childhood Education of the Cuban Ministry of Education was requested. Participants from urban communities were recruited in collaboration with community doctors in different municipalities, using convenience sampling. In rural areas (i.e., in Palma, Santiago de Cuba), parents/caregivers whose children attended kindergartens were contacted and recruited using convenience sampling. The background questionnaire was read aloud to participants who completed the interview over the phone and the researcher filled in their responses. It was not possible to send the forms electronically to all parents/caregivers, due to lack of phone or internet connectivity in some of the cases.

2.3 | Participants

In total, 53 parents/caregivers were interviewed for this study. It is important to note the differences in sample sizes between Mexico ($n = 13$) and Cuba ($n = 40$). Data saturation was found after 12 participants in Mexico, and demonstrated the depth of information that was gathered from these participants. The quantity of Cuban interviews equalivated the depth that was gained from the Mexican interviews. Transcription and translation of the interviews was ongoing during the data collection process. It was noted that the interviews in Cuba were considerably shorter than those in Mexico; thus, data collection was extended with Cuban participants to ensure that similar breadth and depth of understanding of the topic could be ascertained in both sites.

2.4 | Participants: Mexico

Parents/caregivers whose children attended public preschools and nurseries belonging to the Mexican Social Security Institute (IMSS for its acronym in Spanish) in Chihuahua (Northern Mexico, a border state with the United States) were recruited as participants using convenience sampling. Participants included 13 parents/caregivers of children between 39 and 60 months ($M = 46.69$ months), all of whom were living in urban areas. One participant was excluded post-interview as their child did not meet the age criteria. Table 1 summarises the demographic data of the participants and their children.

When considering SES, data were converted into the three-class version described in the National Statistics Socio-economic Classification (NS-SEC; Rose & Pevalin, 2010), which can be assumed to involve a form of hierarchy (i.e., high, medium and low SES categories). Parents/caregivers completed eight questions from the NS-SEC (Rose & Pevalin, 2010), which derived socio-economic status (SES) using the Standard Occupational Classification (SOC). In 2019, the state of Chihuahua occupied the 11th position with a contribution to the Mexican GDP of 3.2% (INEGI, BIE, 2021a). In 2020, SES in Chihuahua was distributed as follows: low-SES 8.3%, middle-low-SES 43.0%, middle-high-SES 35.1% and high-SES 13.5%. Of the total population aged between 20 and 49 years old, the highest levels of education are as follows: 1.8% no qualification, 0.11% preschool education, 13.8% primary education, 31.9% secondary education, 23.4% high school, 22.6% undergraduate and 3.02% graduate, other 3.4% (INEGI, CENSO, 2020). Within the current sample, we have representation from all levels of SES (Table 1). However, the sample is skewed towards participants with higher educational experience than the population norms (Table 1).

2.5 | Participants: Cuba

Interviews were conducted in person at the children's day care centre ($N = 9$) with the permission of the Director of the day care centres. In urban areas (i.e., La Havana), due to mobility restrictions associated with the COVID-19 pandemic, the interviews were carried out by phone ($N = 22$) or in person ($N = 9$) depending on the municipality and parents/caregivers preference. The breakdown between rural and urban participants (Table 1) is representative of the Cuban population as the rural population in Cuba was 22.96% (i.e., the percentage of total population) as of 2018. All parents/caregivers had at least one child aged between 36 and 59 months ($M = 47.68$ months).

TABLE 1 Demographic data for Mexican and Cuban participants.

			Participants, *n* (%)
Mexico ($N = 13$)	Gender of child	Female	3 (23)
		Male	10 (77)
	Gender of parent/caregiver	Female	11 (85)
		Male	2 (15)
	Day care	Preschool	8 (64)
		Nursery	5 (36)
	SES	High	2 (14.3)
		Medium	8 (64.3)
		Low	3 (21.4)
	Highest level of education	Higher Education Degree	8 (53.8)
		Middle school/junior high	1 (7.7)
		High school	4 (30.8)
	Highest level of mathematical	Higher Education Degree	6 (46.2)
		Middle school/junior high	2 (15.4)
		High school	5 (38.5)
Cuba ($N = 40$)	Gender of child	Female	22 (55)
		Male	18 (45)
	Gender of parent/ caregiver	Female	38 (95)
		Male	1 (2.5)
		Grandmother	1 (2.5)
	Area	Urban	31 (77.5)
		Rural	9 (22.5)
	Day care	Public	29 (72.5)
		Private	8 (20)
		Not attending	7.5 (3)
	SES	High	24 (60)
		Medium	11 (27.5)
		Low	4 (10)
	Highest level of education	Postgraduate Degree	1 (2.5)
		Higher Education Degree	18 (45)
		Middle-level Technician Degree	8 (20)
		High school/preparatory school	12 (30)
		Primary school	1 (2.5)
	Highest level of mathematical	Higher Education Degree	8 (20)
		Middle-level Technician Degree	8 (20)
		High school/preparatory school	23 (57.5)
		Primary school	1 (2.5)

Note: A: Low SES category involves routine and manual occupations (i.e., gym instructor), medium SES category involves intermediate occupations (e.g., general nurse) and high SES category involves higher managerial, administrative and professional occupations (i.e., lawyer); B: Higher education degrees in Mexico include undergraduate level degrees. Mathematical education was defined as including any degree that involves mathematical or statistical training (e.g., physics, engineering, statistics etc.).

In Cuba, the last population and housing census was carried out in 2012. At the time of data collection, the percentages per education level of the total population aged 20 to 49 years old were as follows: no qualification (2.1%), primary education (5.4%), middle school/junior high (22.8%), high school/preparatory school (32%), middle-level technician degree (19.3%), higher education degree (15.9%), other (2.4%) (ONEI, 2014). Therefore, the sample in our study is skewed towards higher educational experience than the population norm (Table 1).

In Cuba, there is no national official classification or reference of the population SES. However, in 2019, the average GDP per capita was $8.82 dollars, with Cuba ranking 75th out of the 196 countries included in the analysis (Expansión, 2021). According to this, overall, the Cuban population has a low standard of living. However, as for the Human Development Index (HDI), used by the United Nations to measure the progress of a country by taking into account life expectancy at birth in years, expected years of schooling, mean years of schooling and Gross National Income (GNI) per capita (PPP $), Cuba was ranked 70 in 2019, and classified as a country with High Human Development (Miščević, 2021). Given the social and economic context in Cuba, this classification may not truly reflect SES stratification in the country as data on SES are not systematically collected. However, within the current study, the only feasible measure that could be collected with participants was SES, this was skewed towards higher levels (Table 1).

2.6 | Data analysis

The two researchers (in Mexico and Cuba) completed 52 interviews in total. The interviews were digitally recorded with a dictaphone for accuracy, transcribed verbatim and translated from Spanish to English. Thematic analysis was carried out on the Spanish transcripts of the semi-structured interviews, to identify themes in participant responses for each country separately.[1] ATLAS.ti software was used for analysis in Mexico, whereas in Cuba, interviews were analysed by hand. This was due to communication issues during the COVID-19 pandemic lockdowns in which Cuban collaborators had very limited internet access. Thematic analysis was completed on all of the Spanish transcripts by the first coder (the researcher either in Mexico (DP) or Cuba (YC)). An inter-rater reliability measure was applied with a second coder to ensure coding reliability for 10% of the English transcripts by a second coder (a researcher in NI (AC)) for both countries. Both coders (either Mexican and Northern Irish researchers or Cuban and Northern Irish researchers) identified the same codes, enhancing coding credibility. This study aimed to replicate the methodological approach taken by Cahoon et al. (2017), which was specifically ontological and inductive. To approach this research free from epistemological ideals, it was extremely important for the first coders to be from the Mexican and Cuban teams, and for these teams to attempt to solely analyse the transcripts using a data-driven approach.

Thematic analysis was conducted separately for both countries and followed six analytic steps (Braun & Clarke, 2006; Braun & Clarke, 2019), replicating the methodological approach of Cahoon et al. (2017). The first and second coder read over the data or transcripts to *familiarize themselves with the data* and noted initial ideas; they then *generate initial codes* and matched codes across the whole data set. The codes that were generated for both analyses (i.e., for Mexico and Cuba) are provided in the supplementary materials D, Table 1 (Mexico) and Table 2 (Cuba). Codes were generated in a systematic and methodological way by reading each transcript separately, coding the entire data set and then collating data/quotes relevant to each code. The two coders *searched for themes* by grouping codes together into potential themes. Table 1 and Table 2 in Supplementary Material D presents the codes grouped within their themes to aid the reader in understanding how the codes contributed to the development of themes. The coders *reviewed the themes*, ensuring that strong evidence existed to support the theme within each transcript (Level 1) and across the whole data set (Level 2) to create a thematic 'map' and then they *defined and named each theme* by carefully considering the content of each theme and ensuring that this is reflected in any definition and title. The final step involved *writing the results* by selecting compelling quotes that illustrated the themes, research questions and cognisant literature. All identifiable information about participants was removed when presenting extracts from the transcripts. We recognise that best practice in thematic analysis is to include participant reflection on transcriptions and findings. However, this research was conducted during the COVID-19 pandemic, making these types of processes extremely difficult to engage with. Therefore, we were not able to complete this final process.

3 | RESULTS

The major aim of this study was to replicate the work of Cahoon et al. (2017) in two different country contexts—attempting to identify if similar themes (i.e., Numeracy Environment Structure, Frequency of Number-related Experiences, Levels of Number Knowledge, Views of Technology, Parent–child Interaction and Social Interaction) would be identified in data from Mexican and Cuban parents/caregivers.

Within the Mexican participants' data five themes were found based on the 19 codes that were generated through the thematic analysis: "Numeracy Environment Structure" (5 codes), "Expectations and Attitudes" (3 codes), "Views of Technology" (4 codes), "Interactions Related to Reading or Mathematics" (4 codes), and "Child's Attitudes in Relation to Mathematics" (3 codes). Within the Cuban participants' data four themes were found based on the 18 codes that were generated: "Numeracy Environment Structure" (4 codes), "Expectations and Attitudes" (3 codes), "Views of Technology" (6 codes) and "Interactions for Learning Mathematics" (5 codes). A table of codes generated through thematic analysis, the definitions of the codes and how these relate to themes is presented in Supplementary Material A, Table 2 for the Mexican sample, and Supplementary Material A, Table 3 for the Cuban sample.

The thematic analyses indicated that there were common themes across Mexico and Cuba including "Numeracy Environment Structure", "Expectations and Attitudes" and "Views of Technology". Unique themes generated from the Mexican parent/caregiver data were "Interactions Related to Reading and Mathematics" and "Child's Attitudes in Relation to Mathematics". Cuban parent/caregiver data generated a unique theme on "Interactions for Learning Mathematics" that solely focused on mathematical content. The following *Results* section will focus on the thematic analyses findings, beginning with common themes across the two countries. Subsequently, unique themes found in each country are then reported. The Spanish and English versions of supporting quotes are provided to demonstrate participants' language and cultural nuances.

3.1 | Common theme: Numeracy environment structure

The "Numeracy Environment Structure" theme relates to how the activities related to numeracy in the home are informed and organised. This theme was identified in data from both Mexican and Cuban parents/caregivers.

Data from Mexican parents/caregivers informing this theme discussed the link between the information provided by the learning facility the child attends (e.g., local day care centres) and how mathematics is taught through activities occurring in daily life. These activities are used to create resources and support learning opportunities to enhance mathematical knowledge using materials available in the home. All Mexican participants reported that they obtain information on numerical practices from their child's learning facility, using this information as a foundation to develop and implement home practices that promote children's numeracy skills, but also mentioned that they enhance numerical knowledge at home by relying on activities that occur in their daily life (e.g., food, tools, clothing, daily commute):

“Pues si tanto como de internet, y en la guardería donde las asistentes me dicen de actividades, para ponerle en casa.”—Madre, hija (3 años), México	“Well, yes both from the internet, and from the nursery school where the assistants tell me the activities to use at home…”—Mother, Daughter (aged 3), Mexico
“Sí. El hace la limonada con trece limones y los cuenta…”—Madre, Hijo (4 años), México	“Yes. He makes lemonade with thirteen lemons and he counts them…”—Mother, Son (aged 4), Mexico

These findings indicated that Mexican participants recognise that they are engaging their children with mathematical ideas through everyday spontaneous activities. In addition, some participants reported making their own mathematical material specifically developed for enhancing numeracy skills and, at the same time, may be used to promote other abilities (i.e., fine motor skills). These participants also mentioned that they used direct instructions, breaking down mathematical tasks and clear corrections to encourage their child to learn about mathematics:

“Los números los escribo en habas o por ejemplo manualidades. Me he enfocado mucho en que sea más diestro con sus con sus dedos, porque lo que he notado es que no le gusta escribir como nosotros agarramos el lápiz, él lo agarra con todo el puño…”—Madre, hijo (3 años), México	“With numbers, I write them down with beans or handicrafts. I have focused a lot on him being more skilled with his fingers, because I have noticed that he doesn't like to write as we hold the pencil, he holds it with the whole fist…”—Mother, Son (aged 3), Mexico

Cuban participants perceived that there was a lack of organised activities when teaching numeracy at home, given that the number-related activities are generally unplanned and spontaneous everyday activities. Parents/caregivers took advantage of their child's interests (i.e., with games and toys) to teach mathematics. Participants introduced and discussed numeracy activities informally through everyday activities:

“Ya ella cuenta del 1 al 11. A mí me gusta hacer panetela, y entonces yo le digo: “ve al refrigerador y tráeme 4 huevos”, y entonces ella va, cuenta y me trae los 4 huevos. Igual cuando vamos por la calle o estamos asomadas en el balcón, le digo: ¿cuántos carros hay? Y ella va contando, cuando llega al 11 empieza de nuevo, 1, 2…”—Madre, hija (3 años), Cuba	“She already counts from 1 to 11. I like to make pancakes, and then I tell her: “go to the refrigerator and bring me 4 eggs”, and then she goes, counts the eggs and brings me back 4. Also, when we walk on the street or we are leaning on the balcony, I tell her: how many cars are there? And she counts one by one, when she reaches 11 she starts over again: 1, 2…”.—Mother, Daughter (3), Cuba

Cuban participants' responses indicate that they used available objects that their children were interested to teach mathematics, providing children with learning opportunities to acquire number knowledge. The types of activities that occurred seemed to vary by available resources (i.e., toys, objects) and the numerical concepts being taught (i.e., numbers or numerical language such as big or small):

“Le pongo canciones que dicen los números y que los representan visualmente y jugamos juegos de conjuntos, para que los agrupe por colores y tamaños”—Madre, hija (3 años), Cuba	“I play songs for her that say the numbers and then represent them visually and play games of sets, so that she can group them by colour and sizes”—Mother, Daughter (3), Cuba

Cuban parents/caregivers indicated that the learning environment structure may change as children become older because caregivers begin to more regularly employ structured strategies to teach numerical content, through the introduction of daily homework sent home from school settings Nevertheless, unstructured learning activities (i.e., counting available objects) continued as children became older as the numeracy activities were brought up spontaneously (by children and caregivers) and seemed to be entertaining for the children.

"Yo lo he acostumbrado a hacer tareas, no lo hacemos todos los días pero es para que él se vaya haciendo la idea de que en algún momento tiene que sentarse a hacer tareas, y que eso no sea un problema cuando empiece en Preescolar. Además, mi sobrino, que ya está en primer grado, vive con nosotros, y todos los días hace las tareas, y entonces mi niño me dice: mamá vamos a hacer las tareas, es hora de hacer las tareas"—Madre, hijo (4 años), Cuba	"I've been trying to get him used to his homework, we don't do it everyday but I'm trying to get him to realize that, at some point he has to sit down and do his homework so that it won't be a problem when he starts in preschool. Also, my nephew, who is already in first grade, lives with us, and he does his homework every day, so my child tells me: "mum let's do the homework, it's time to do the homework".—Mother, Son (4), Cuba

Cuban participants reported that reading was a regular interaction and occurred before bedtime, whereas number-related interactions occurred at any time of day and thus appeared to be more sporadic.

Cuban participants also suggested that reading did not just rely on story books as prompts, parents/caregivers reported using a wide variety of objects or illustrations to encourage reading together. Hence, the home literacy environment could also be unstructured at times:

"En la casa no leemos muchos libros, pero sí muchas etiquetas. A ella le gusta leer mucho las etiquetas, cada vez que ella ve una etiqueta en algo nuevo, como un juguete o ropa o algo de alimento, algún recibo de compra, me pide que se lo lea. Es que como tienen números, parece que le llama la atención. Pero la verdad, eso tengo que mejorarlo, yo sé que tengo que leerle más, pero no tengo mucho tiempo"—Madre, hija (4 años), Cuba	"We don't read many books at home, but we have read lots of labels. She likes to read labels a lot, every time she sees a label on something new, like a toy or clothing or some food, a purchase receipt, she asks me to read it to her. I think it is maybe because it has numbers, it seems that it catches her attention. But the truth is, I have to improve that, I know I have to read more to her, but I don't have much time."—Mother, Daughter (4), Cuba

Cuban participants reported that everyday objects, including books, were used to expose children to mathematical content. Therefore, both reading and mathematics activities may have I in both structured and unstructured ways. In addition, some Cuban participants reported having books that were number-related, thus these reading/storybook interactions could be used to encourage children's number learning in a relatively structured way:

"Yo le leo cuentos para niños. A él le gusta mucho el cuento de "Los tres cerditos" y ya se lo sabe y me lo cuenta a mí"—Madre, hijo (3 años), Cuba	"I read children's stories to him. He really likes the "3 little pigs" tale and he already knows it and he tells it to me"—Mother, Son (3), Cuba

Overall, parents/caregivers are aware of the spontaneous nature of mathematical practices and the mathematical language and instruction that they use with their children and the benefit of using objects as visual aids to engage their children. Parents/caregivers adjust their behaviour according to the child's learning needs (for example, using imitation as a correction technique) and, at the same time, they use physical material to teach and reinforce numerical skills.

3.2 | Common theme: Expectations and attitudes

The "Expectations and Attitudes" theme explores participants' expectations and views of their child's performance in mathematics, emphasising parents'/caregivers' perceptions of the importance of mathematical skills later in life. This theme was identified in both Mexican and Cuban parents'/caregivers' data. This theme indicates that the interests, expectations and attitudes of parents/caregivers influence a children's mathematical learning environment and irrelevant of the participant's own interest in mathematics, caregivers still engage children in numerical learning at home. This theme also explores participants' predictions of the highest level their children will achieve in mathematics.

Mexican caregivers were aware of the importance of the development of numeracy skills and have expectations that are appropriate to their child's level of mathematical development. However, Mexican parents/caregivers compare their children's performance to that of their schoolmates/peers which has not always been possible during the COVID-19 lockdown. Therefore, some parents may have found it difficult to gauge their child's development in relation to other children of the same age:

"Mira, yo pienso que más adelantado, pero es algo que yo considero porque pues como realmente ahorita ni siquiera está yendo a la guarde, no puedo compararlo con otros niños"—Madre, hijo (3)	"Look, I think it's more advanced, but it's something I consider because right now he's not even going to daycare, I can't compare him with other children"—Mother, Son (3)

Participants reported wide-ranging personal attitudes towards mathematics, which may have been influenced by their own school experiences. Some participants reported showing no interest in mathematics throughout their own education, whilst in contrast others reported high interest in mathematics during their education:

"… ¿Cuándo yo estaba en la escuela? ¡Ay no! A mí no me gustaban las matemáticas. Sí, nada. nada hasta la fecha no me gustan…"—Madre, hijo (3 años), México	"…When I was at school? Oh no! I did not like maths. No, at all. At all, even today, I still don't like them…"—Mother, Son (3), Mexico
"… ¡Ay! a mí me encantaban las matemáticas. Sí, a mí física y matemáticas, cálculo y todo eso me encanta…"—Madre, hijo (3 años), México	"…Ah! I loved maths. Yes, I love physics, maths, calculus and all that I love it"—Mother, Son (3), Mexico

However, throughout the interviews, Mexican participants, independent of their level of interest in mathematics during their own education, reported engaging in numeracy practices with their children. Thus, participants may realise the importance of mathematical skills for their children irrelevant of their own interest. In addition, participants mentioned that they expected their children to have good mathematical performance in the future. Participants articulated that they were also able to reflect on their child's mathematical skills in the context of their child's age, supporting their acquisition of numeracy skills without pressuring them to learn more:

"…Pues que sea muy buena en eso porque las matemáticas son esenciales para todo…"—Madre, hija (3 años), México	"…Well, for her to be very good at that, because maths is essential for everything…"—Mother, Daughter (3), Mexico
"…Él reconoce los números del uno al… bueno, del cero al nueve, he sabe contar hasta el treinta y cinco más o menos. Sabe hacer sumas con números chicos con números que no sumen más de más de diez. Entonces, según yo para el nivel adecuado, poquito adelantado para su edad…"—Padre, hijo (3 años), México	"…He recognizes the numbers from one to… Well, from zero to nine, he knows how to count up to thirty five more or less. He knows how to make additions with small numbers that add up to numbers smaller than ten. So, I believe he's at the right level, a bit ahead for his age…"—Father, Son (4), Mexico

These findings suggest that Mexican participants have realistic, age appropriate, expectations with regards to their children's current mathematical development. In relation to this, however, participants recognise due to COVID-19 lockdowns, they may lack the insight to compare their own child with others. These participants believed that their children had good mathematical skills, but it was also important for them to have observed other children as reference points to ascertain this.

"…Pues yo creo que lo veo bien, no, porque está adelantado, por ejemplo, cuenta ahorita hasta el veinte. No tengo comparación, nada, así como no hay convivencia con otros niños no tengo comparación como anden los demás…"—Madre, hijo (4 años), México	"…Well I think he is doing good, no, because he is ahead, for example, now he can count up to twenty. I don't have something to compare with, anything, since there is no interaction with other kids I can't compare him with other children…"—Mother, Son (4), Mexico

Cuban participants stated that their children were able to engage in and understand basic numerical concepts (e.g., compare sets of objects, count). Most participants thought that it was only necessary for their children to count to 10 before preschool while others encouraged their children to count higher than 10, forwards and backwards, and even to recognise written numbers. However, all participants expected their child to be good at mathematics:

"Ella reconoce los números del 1 al 10, y ya está aprendiendo a reconocer el 11, 12 y 13. Ella no tiene problema con los números y estoy tratando, poco a poco, de enseñarle el resto de los números siguientes"—Madre, hija (3 años), Cuba	"She recognizes the numbers from 1 to 10, and she is already learning to recognize 11, 12 and 13. She has no problem with numbers, and I am trying, little by little, to teach her the rest of the following numbers"—Mother, Daughter (3), Cuba

Cuban participants suggested that children should be exposed to mathematical concepts every day, perhaps reflecting their recognition of the importance of mathematics for their children's future. These participants especially understood the importance of teaching mathematical concepts to their children as they are foundational skills necessary for life, both within and outside of educational attainment:

"Yo creo que ella debería aprender mucho matemáticas, porque en la vida todo depende de las matemáticas, y tenemos que analizar, entender y apropiarnos de las matemáticas y creo que el que no aprenda matemáticas está muy perdido en la vida, porque todo lleva analisis matemático para sabre las prioridades y es importante para todo ser humano"—Madre, hija (3 años), Cuba	"I think that she should learn mathematics a lot, because in life everything depends on mathematics, and we have to analyse, understand, do the maths ourselves and I think that whoever does not learn mathematics is very lost in life, because everything takes mathematical analysis to know the priorities and is important for every human being."—Mother, Daughter (3), Cuba

Some Cuban participants suggested that they wanted their children to be good at mathematics but had no specific goals, while others described specific aspirations, such as to achieve a university degree (or even higher) in mathematics. These higher level goal settings may also have been reflected in the participants' emphasis in ensuring their children were exposed to mathematical concepts and activities at home to ensure early learning:

"Yo quiero que él gane un Premio Nobel (se ríe), si voy a apostar, apuesto alto"—Madre, hijo (4 años), Cuba	"I want him to win a Nobel Prize (she laughs), if I'm going to bet, I'll bet high"—Mother, Son (4), Cuba

3.3 | Common theme: Views of technology

The "Views of Technology" theme was identified in both the Mexican and Cuban data. This theme discussed how parents/caregivers used technology in the home and how usage was monitored and/or restricted. Attitudes towards technology for learning are also central to this theme.

Mexican parents/caregivers reported that technology was used to learn new information and reinforce numerical skills through interactive elements. Mexican caregivers were cautious about using technology for long periods of time with their children; however, due to COVID-19 lockdowns, caregivers relied on technology to keep their children entertained whilst working from home and used it as an engagement or distraction method. Mexican participants reported that their child learnt mathematics using technology through both passively observing information (i.e., watching videos) and engaging in interactive activities (i.e., didactic applications):

"…Carlos acostumbra, estar el IPad. En YouTube Kids hay un área específica que se llama aprendizaje. En aprendizaje les enseñan los animales, les enseñan los colores, les enseñan los números. La verdad es que Carlos aprendió los números, no, porque yo sólo se enseñara la realidad es que él sólo los adquirió por ese tipo de vídeos y como que fue empezando a clasificar entonces ya luego él empezó a contar los escalones cuando sube en la casa o así ve cositas que son varias y las empieza a contar, él ya ve algo más de uno y empieza a contar…"—Madre, hijo (3 años), México

"…He is usually on the iPad. On YouTube Kids there is a specific area that is called *learning*. In *learning* they teach them the animals, colours and numbers. The truth is he learned the numbers not because I taught him, he actually acquired them from this kind of videos, and he began classifying, then he started counting the steps when he goes up the stairs, or he sees things in a bunch and starts counting, when he sees something and there are more than one he starts counting…"—Mother, Son (3), Mexico

The previous quote (i.e., Mother, Son (3)) demonstrates that the mathematical content that children learnt from engaging with technology was transferred to interactions and learning from their physical environment (for example, they are counting objects spontaneously). The use of technology enabled children's independence in learning (see the following quote also), but importantly children were able to link this information to real-world problems. In addition, most Mexican participants reflected positive attitudes to technology use and its beneficial influence on children's learning:

"Yo no le he enseñado nada de números. Él lo ha aprendido por el medio tecnológico y me da mucho gusto porque yo no sabía, por ejemplo, cuando empezó a contar yo así de ¡Ah caramba! De donde empezó a contar o tipo los colores de que rojo, amarillo. La verdad es que pues no es algo que yo le he enseñado tiene que ser derivado de la escuela y del de los aprendizajes en la tecnología…"—Madre, hijo (3 años), México

"…I haven't taught them anything about numbers. He has learned it through technology and I am glad because I didn't know, for example, when he began counting I was like, "What?!" Because he began counting, or like with the colours, like, "red, yellow". Honestly, well it is not something I taught him, it has to come from the school and from what he learns using technology…"—Mother, Son (3), Mexico

Mexican participants mentioned that they believed that technology helped children acquire and reinforce more mathematical knowledge. However, some participants thought that technology does not promote the skills necessary to acquire mathematical knowledge, or broader academic skills, and thus limited its use in the home:

"…Nosotros no, no le fomentamos tanto el estar pegados al dispositivo electrónico, entonces, en nuestro caso lo…lo que hacemos es que todo sea, sea presencial, sea por actividades por…pues sí, o sea, por fomentar la actividad o la, la destreza del niño…"—Padre, hijo (4 años), México

"…we don't, we don't encourage using the electronic device all day, in our case we… what we do is that everything is face-to-face, be it through activities… well yes, I mean, we encourage the kid's activity or dexterity…"—Father, Son (4), Mexico

The length of time children were allowed to use technology for learning varied from household to household depending on the caregivers view on the usefulness of technology for learning. Mexican caregivers reported that they preferred to teach mathematics and/or literacy using physical material compared with relying on technology to teach mathematics, even though they recognised that technology could support their children's learning. Most Mexican participants reflected positive attitudes to learning mathematics through technology use, stating that they believed their children applied what they learned from technology in their physical environment.

Most Cuban participants also allowed their children to use technology devices (e.g., television, phones and tablets) for playing games and watching programmes. Cuban participants considered technology a motivating way of introducing basic numerical concepts and explained that they controlled the content of games and programmes, preferring those with a potential educational learning gain:

"Ella tiene una aplicación en mi celular que es un juego de enseñanza para preescolares, donde aprende a trabajar con conjuntos y números. También yo le enseño los números en la pantalla y después pongo el altavoz para que ella los escuche y trate de identificar qué número es, de acuerdo a lo que vio en la pantalla"—Madre, hija (4 años), Cuba	"She has an app on my phone that is a teaching game for preschoolers, where she learns to work with sets and numbers. I also show her the numbers on the screen and then I put it on speaker so she can listen to them and try to identify which number it is according to what she saw on the screen"—Mother, Daughter (4), Cuba

Cuban participants realised the importance and benefits of engaging in technology games and programmes with their children. Caregivers understood that directing and interacting with their child whilst using technology was sometimes necessary for their child to learn content from the screen whilst being supported by a more knowledgeable person:

"Hay muchos programas y juegos encaminados específicamente al aprendizaje. Estos juegos los ayudan, pero necesitan el acompañamiento de una persona especializada. Es como cuando los niños están viendo videos, que no pueden estar todo el tiempo ahí solos, sin hablarles. Los padres deben comentarles y hacerles preguntas acerca de lo que está pasando en el video. A mi me gusta mucho hablar con Diego, porque eso lo ayuda a retener las palabras"—Madre, hijo (3 años), Cuba	"There are many programs and games aimed specifically at learning. These games help children, but children need the company of a specialized person. It's like when kids watch videos, they can't be alone all the time, with no one talking to them. Parents should comment with the child and ask questions about what's happening in the video. I like to talk to Diego, because that helps him to retain the words".—Mother, Son (3), Cuba

Cuban participants recognised that a child's interest in technology could also increase engagement in topics (i.e., mathematics) that they may not regularly wish to engage with. Cuban parents/caregivers believed that technology motivated their child to engage in learning mathematics using a wide range of applications and various content:

"La tecnología es muy útil, por lo menos con él me ha ayudado muchísimo. Yo pienso que a los niños hay que tratar de enseñarles, especialmente las cosas que no les gusta, usando lo que más les gusta. En mi caso, a él lo que le gusta es jugar y ver videos en el Tablet, así que yo descargué canciones que él pueda ver en el Tablet que tengan números, y así fue como él se fue familiarizando con ellos hasta que se los aprendió"—Madre, hijo (4 años), Cuba	"Technology is very useful, at least it has helped me a lot with him. I think that you have to try to teach children, especially the things that they do not like, using what they like the most. In my case, what he likes the most is to play and watch videos on his tablet, so I download songs about numbers, that he can listen to on the Tablet, and that is how he started getting familiar with numbers until he properly learned them"—Mother, Son (4), Cuba

Although most Cuban participants recognised the value of using technology as a tool for learning, some Cuban participants did not allow their children to use technology frequently due to a number of reasons (i.e., too young, worried their child could become addicted to using technology). Cuban participants reported that they received recommendations for technology-based home mathematics activities mainly from teachers at their child's learning facility. However, participants also reported finding their own online materials that they felt were suitable for their children at home. These participants also discussed the importance of parents setting time limits for the use of technology, to ensure that children had a variety of experiences throughout the day:

"Yo creo que la tecnología puede ser muy buena si se usa adecuadamente. Por eso yo chequeo lo que ella está haciendo … y le pongo un tiempo límite para que use tecnologías … por lo que no puede usarlas todo el tiempo"—Madre, hija (3 años), Cuba	"I think technology can be really good if it's properly used. That's why I check what she is doing… and I set a time limit for the use of technology… so she can't use it all the time".—Mother, Daughter (3), Cuba

Overall, both in Mexico and Cuba, educational technology (i.e., games or programmes) appeared to have an important place within the home learning environment. Participants do not necessarily rely on technology but do view these tools as a valuable teaching aid to teach their child about mathematics. However, they do approach technology use with caution and attempt to limit their children's use of these devices.

3.4 | Unique theme: Mexico only: Interactions related to reading and mathematics

The "Interactions Related to Reading and Mathematics" theme explored the influence of wider family members that attempt to support the acquisition of reading and/or mathematical knowledge and that potentially scaffold children's learning. This theme was only identified in Mexican parent/caregiver data, although one Cuban parent/caregiver did mention story book reading with their child—this was only mentioned in terms of the structure of the HME and was not sufficient to generate a theme for Cuban participants around reading and mathematics.

Mexican participants reported reading storybooks to their children frequently (i.e., once a week or daily). Joint reading activities mainly occurred before bedtime, providing a structured routine, and were sometimes prompted by assigned books from their child's teacher. Mexican participants reported that reading with their child occurs between 3 and 20 min per day:

"…Mira, le leo…pues como unos quince veinte minutos leemos. Yo creo hasta que le da el sueño porque quiere otro y cuéntamelo otra vez…"—Madre, hijo (3 años), México	"…I read to him… well we read for about fifteen or twenty minutes. I think until he gets sleepy because he is like "I want another one, read another one" and "read it again"…"—Mother, Son (3), Mexico

Mexican participants were the main caregivers involved in reading at home with their children, although other family members, specifically grandparents were also involved in these interactions. In contrast, Mexican participants mentioned that other family members, including godparents, aunties and siblings, were likely to get involved with mathematical activities:

"…Su madrina es maestra entonces a veces… a veces se va un día a la semana con ella y le digo y haber pregúntale tú los números…"—Madre, hijo (3 años), México	"…His Godmother is a teacher so he sometimes… goes with her for one day a week and I tell her "you ask him the numbers…"—Mother, Son (3), Mexico

Overall, Mexican participants report shared book reading as being an activity that occurs mainly between caregiver and child (i.e., either mother or father and child), whereas mathematical activities can involve multiple people in the home, including siblings.

3.5 | Unique theme: Cuba only: Interactions for learning mathematics

In contrast to Mexican participants, Cuban participants' discussions focused mostly on their own interactions with their child around mathematics and they did not substantially mention interactions around reading. Therefore, the unique theme "Interactions for Learning Mathematics" was only identified in the Cuban parent/caregiver data.

Cuban participants reported supporting their children to learn and practice number-related activities through numerous different interactions and strategies such as support and encouragement both verbally (i.e., encouragement through further questions) and visually (i.e., demonstrating the numerical problem using concrete materials) or simply providing the answer without aiding the child's understanding of the problem. Cuban participants engaged their children in activities that they believed would encourage and motivate them to engage in learning mathematics, such as counting songs and rhymes. Cuban participants also used verbal encouragement and prompts to support their child to learn numbers both through reciting numbers (or rote counting) without objects and/or demonstrating mathematical concepts through objects:

"La mayoría de las veces yo hago la actividad primero, y después él la repite. Algunas veces cuando está armando rompecabezas, y no sabe qué hacer, yo le digo: piensa, inténtalo de nuevo, encuentra otra manera. Lo dejo pensar un rato y encuentra la solución"—Madre, hijo (3 años), Cuba	"Most of the time I do the activity by myself first, and then he repeats it. Sometimes when he is putting puzzles together, and he doesn't know what to do, I tell him: think, and try again, find another way. I let him think for a while and find a solution."—Mother, Son (3), Cuba

Cuban participants had an understanding of the level at which they had to break down and explore numerical problems with their child. Cuban participants reported using strategies such as providing direct instructions, correcting their child's answers about numerical problems and demonstrating the solutions of numerical problems visually using concrete objects to support their child to learn numbers:

"Lo corrijo. Le digo que empiece desde el principio si se equivoca. Trato de que no se aprenda las cosas de memoria. Por ejemplo, Le pongo los bloques delante de él, con los números del 1 al 10 en el orden correcto, y después se los pongo en distinto orden para que él los ordene correctamente"—Madre, hijo (4 años), Cuba	"I correct him, I tell him to start from the beginning when he makes a mistake. I try to teach him not to learn things by heart. For example, I put the blocks in front of him, with the numbers from 1 to 10 in the right order, and then I put them in a different order so he can sort them out correctly"—Mother, Son (4), Cuba

Cuban participants highlighted the importance of establishing a positive home mathematics environment, using the child's interests to encourage their learning and attract their attention. This way, the Cuban participants believed that they could teach their child through playful learning experiences:

> "Jugando, siempre jugando, para que no lo vea, ni se sienta presionada como si fuera una tarea o algo así. Yo le digo vamos a jugar, y ella se sienta en su buró, porque ella tiene un buró chiquitico. Entonces realizamos las actividades, porque yo le tengo muchas cosas que son de preescolar, por ejemplo diferentes figuritas de colores. Se ven las formas, o sea, los triángulos, cuántas puntas tiene, que eso supongo que sean cosas de matemática ¿no? Los cuadrados, ver cuántos lados tiene iguales, los rectángulos, y hacemos lo mismo con diferentes figuras. Entonces después las agrupamos por cantidad, por colour, y esas cosas"—Madre, hija (4 años), Cuba

> "Playing, always playing, so she doesn't feel pressured like it's homework or something like that. I tell her let's play, and she sits on her desk, because she has a small desk. Then we do the activities, because I have many things for her that are from preschool, for example different kinds of coloured figures. So, you can see the shapes, for example, the triangles, how many points it has, which I suppose is maths, right? The squares, see how many sides it has, the same, and we do the same with different figures. So then we group them by quantity, by colour, and things like that."—Mother, Daughter (4), Cuba

In addition, Cuban participants, similar to Mexican participants, recognised that learning about mathematics in the home can take place with other people. Interactions with more knowledgeable others, whether that be with the caregiver or other children in the home, could provide a supportive and encouraging environment for learning mathematics. Specifically, Cuban participants discussed child's social interaction with other children in the home could influence their interests and motivation to learn mathematics:

> "A ella le gustan los números. Le gusta repetirlos. Cuando su hermana mayor estaba aprendiendo más acerca de los números en la escuela, empezó a enseñárselos. La más pequeña estaba muy entusiasmada con eso. Empezó a preguntar por más y más números, insistiendo a la hermana para que continuara contando. No quería cambiar a otras actividades. Por el contrario. Era algo que ella disfrutaba. Todavía lo disfruta"—Madre, hija (3 años), Cuba

> "She likes numbers. She likes to repeat them. When her bigger sister was learning more about numbers at school, she began to teach her. The little one was very excited about it. She starts to ask for more and more numbers, insisting to her sister to continue counting. She didn't want to change to other activities. Quite the opposite. It was something enjoyable for her. It's still enjoyable."—Mother, Daughter (3), Cuba

3.6 | Unique theme: Mexico only: Child's attitude in relation to mathematics

The "Child's Attitude in Relation to Mathematics" theme was only identified in the Mexican data. This theme reflects that children's positive emotions and attitudes can aid the acquisition of new numerical knowledge. Mexican participants recognised that their child's emotions are important for learning mathematics. Mexican parents/caregivers realised that that the child must be in a good mood for positive mathematical activities and interactions to occur between the caregiver and child. Mexican children were described as spontaneously demonstrating their abilities and interest in mathematics through activities that they engage in independently. Mexican participants reported that children were interested in mathematics and spontaneously practiced numeracy activities (e.g., counting) unprompted in daily life through interactions with objects that they had access to. Due to these expressed or demonstrated interests, participants discussed that they felt their child was ready and keen to learn about mathematics:

> "…A veces que ve que estoy limpiando los frijoles y empieza a contarmelos, empieza a darme de uno por uno. Luego me dice "Mira, mamá, este es uno, este es dos, este es tres…"—Madre, hijo (3 años), México

> "…Sometimes he notices I am cleaning beans and he starts counting them for me, he hands me one by one. Then he says "look, mom, this is one, these are two, these are three"…"—Mother, Son (3), Mexico

Mexican participants realise that the child's negative emotions (either related or unrelated) to mathematics do not foster a learning environment that is necessary for children to engage and learn from mathematical activities. Some Mexican participants reported that their child sometimes showed negative emotions when engaging with mathematical concepts, becoming frustrated when taking part in mathematical activities:

"…Sí que le gustan, pero se frustra mucho. Se enoja todavía algunos no los distingue y le causa un poco de frustración, pero si, si le gusta…"—Madre, hijo (3 años), México	"…Yes he likes it, but he gets very frustrated. but also when he doesn't get it right or if he can't distinguish them, he gets frustrated. But he does like it, he likes it, but he gets angry when he doesn't get it right…"—Mother, Son (3), Mexico

4 | DISCUSSION

The current study was the first to qualitatively explore the HME for 3- to 5-year-olds in Mexico and Cuba, replicating the methodological approach taken by research on the HME with participants in NI (Cahoon et al., 2017). The findings included in this paper forms the basis of further research in Mexico and Cuba, underpinning the development of country-specific self-report tools of the HME. The current discourse within HME research emphasises the importance of understanding the nature of the HME in different countries from a qualitative perspective (Hornburg et al., 2021). With clear inconsistencies in HME research findings (e.g., Daucourt et al., 2021), it is important to ensure that measurements of the HME are reflecting the activities, attitudes and resources that are present in children's homes in different country contexts. This research is important as it has allowed for the exploration of constructs across countries that ultimately strengthen theoretical models such as that of Bronfenbrenner's Bioecological model (Bronfenbrenner & Morris, 2007). It confirms that a child's home learning environment is situated within cultural contexts that could have both direct and indirect impacts on a child's development. Further, the universality of some aspects aligns with García Coll et al. (1996) who suggested that family interactions occur within differential cultural contexts.

Figure 2 provides a visual summary of the thematic structure of previous findings from work with participants in NI (Cahoon et al., 2017) and the data from Mexican and Cuban participants in the current study.

Our findings indicated that some themes highlighted home numeracy practices that may be universal, such as the consistent theme of "Numeracy Environment Structure" which was identified in data from both Mexican and Cuban participants, and also previous data collected in NI. All participants discussed the spontaneous and unstructured nature of the HME as well as book reading being a potential source of structure for this content (Cahoon et al., 2017). Participants in both Mexico and Cuba expressed that they teach their children mathematical concepts in the context of everyday activities using objects that are available in their home environment, materials may also be created by families themselves. However, participants in Mexico and Cuba reported that most of the information for teaching their children about mathematics came from their children's school, whereas previous qualitative research in NI suggested this was not the case in NI homes. This more formalised approach to thinking about early mathematics has also been previously reported by Latinx parents in the United States (Galindo et al., 2019). Overall, the data in the current study indicate the home environment structure in Cuba is more formal than in Mexico, in which parents reported a mixture of formal and informal approaches. This finding may reflect the universal approach taken by the Cuban government to early education provision (UNICEF, 2016), which also more broadly may reflect the high value placed on education in Cuban society (Quintero López, 2011). Cuban families receive relatively intensive support and guidance irrespective of whether children are looked after within the home or in childcare centres and all children are exposed to a standardised curriculum. This approach may have a particular influence by training and formalising parenting approaches in the home. During COVID-19, Cuban early years educators interacted

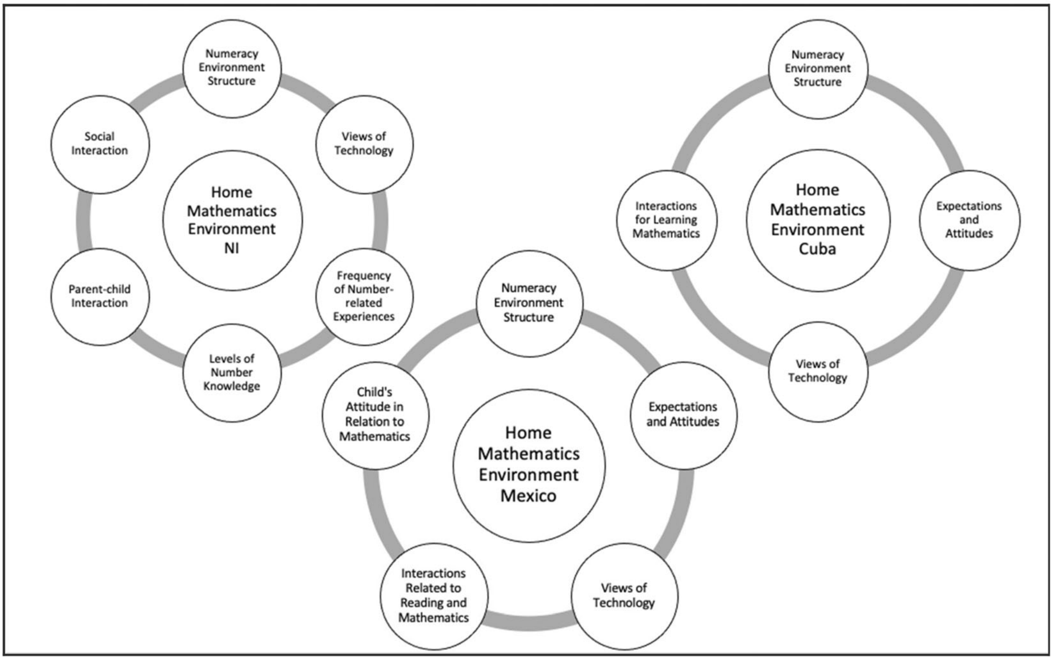

FIGURE 2 Home mathematics environment themes for NI, Mexico and Cuba.

regularly with parents, providing suggestions for home learning activities. This support may have had an additional consequence of heightening the structure of the home learning environment. In contrast, in Mexico, only registered families receive early provision and this is solely in the context of childcare centres. Thus, we may not expect the same extent of influence on the home environment.

Within the "Numeracy Environment Structure" (Mexico and Cuba) and the "Frequency of Number-related Experiences" (NI) themes, parents/caregivers from all countries mentioned the use of book reading to provide structure to the environment and as a prompt for numeracy content delivery. Exposure to mathematical language has been found to be important for general mathematical skill development (Purpura et al., 2017). Participants from Mexico and NI countries indicated that they read to their child before bedtime, thus offering some structure with regard to learning. However, through our analyses, it was apparent that interactions between parents/caregivers and children in Mexico were more balanced between reading and mathematics, hence justifying a separate theme "Interaction Related to Reading and Mathematics". This greater focus on reading storybooks in the home identified in the data from Mexican parents/caregivers may be a product of the geographical location of our sample who were recruited in Chihuahua (a border city close to the United States). In fact, recent research by Beltrán-Grimm (2022) has also observed the influence of border crossing of Latina mothers may have influenced their beliefs around literacy and reading. Shared book reading is regarded as an indicator of quality parenting (Pellegrini, 1991) and is an activity that occurs frequently in the United States (e.g., Read et al., 2022). Thus, migration back-and-forth across the border may have led to changes in parenting culture in the Mexican parent sample. However, previous qualitative research has indicated that Mexican parents have high educational expectations for their children and recognise the importance of exposure to early book reading for learning (Gonzalez et al., 2018). In Cuba, these interactions were dominated by mathematics and therefore fed into a unique theme "Interactions for Learning Mathematics".

There were subtle differences in *who* engages with children around certain activities. Literacy activities commonly occurred with parents or caregivers; this was particularly the case for Cuban participants. Participants from all countries reported that activities for learning mathematical concepts can be promoted by people other than parents (e.g., grandmother, sibling). Given that occurrence of when certain activities vary, with reading activities usually occurring before bedtime in a structured manner though the use of books and mathematical activities occurring spontaneously at any time of the day. The differential nature of how and when reading and mathematics activities occur logically facilitate different family members involvement, with parents/caregivers mainly involved in the calming story time before bed and wider family members being involved in mathematics throughout the day.

A consistent theme of "Views of Technology" was identified both in previous data collected in NI and data from the two samples in the current study. Participants indicated that children have access to, and use, technology; they also reported that children may use technology solely as a form of entertainment (Plowman et al., 2010). In both countries, children may gain knowledge because of this didactic experience, but technology is not always intentionally used to promote numeracy skills. Participants recognised that technology was beneficial for learning, especially when using high-quality content such as educational websites, TV programmes or applications (Ochoa & Reich, 2020). In line with research with parents/caregivers in the United Kingdom, participants also understood the importance of setting the time limits for their children (American Psychologist Association, 2019; Cahoon et al., 2017; Chaudron et al., 2015; Ochoa & Reich, 2020). This restrictive approach to sedentary screen-time use for children under the age of 5 years old is in line with World Health Organization (WHO, 2019) recommendations of "no more than one hour a day, less is better". In Mexico and Cuba, participants reported being offered advice from teachers/childcare workers around technology use and home activities more broadly—this was not the case in NI. Some participants in Cuba reported that they only encouraged their child to use technology because it was suggested by the school.

"Expectations and Attitudes" was a consistent theme identified in Mexican and Cuban parents' data. This was not an identified theme within NI parents' data. Mexican and Cuban parents explicitly stated the importance of their child learning mathematics. In Mexico, participants, regardless of whether they enjoyed mathematics or not during their school years, reported that they engaged in home numeracy practices with their child. This finding may indicate participants have an underlying recognition of the importance of mathematical skills, with participants discussing the importance of mathematics and its bearing on everyday life and their children's future. These findings may reflect embedded cultural norms and attitudes towards high educational aspirations in Cuba and Mexico (e.g., Susperreguy et al., 2021) and thus more positive attitudes to exposing children to mathematical information. In contrast, it has been widely reported that UK populations have poor attitudes to mathematics and thus may have lower, or no clear, expectations of their child's learning in this subject area (National Numeracy, 2020).

The "Child's Attitudes in Relation to Mathematics" was uniquely identified in the Mexican parents' data. However, some overlap is acknowledged between this theme and the "Numeracy Environment Structure" (NI), which indicates some differences in the way participants view their child's interest in mathematics in the home. Mexican participants report that children spontaneously engage in numeracy practices, as do participants in both Cuba and NI. Additionally, Mexican parents suggested this spontaneous practice towards numeracy activities in daily life meant their children were interested in mathematics and felt their child was ready and keen to learn about the subject. Mexican participants emphasised the importance of being sensitive to their children around the topic of mathematics, ensuring that they were not overzealous with their encouragement for children to engage in mathematical activities maintaining a positive mindset for learning. In contrast, in a previous research in NI (Cahoon et al., 2017), some participants felt that although their children may spontaneously engage in mathematics (e.g., through counting objects), the content may have to be masked (i.e., hidden within unstructured activities) if a child was not interested in learning mathematics to ensure engagement.

Overall, addressing both attitudes and expectations of parents across Mexico, Cuba and NI, it is apparent that Mexican parents take a more child-centred and sensitive approach to mathematics within the home environment. In contrast, Cuban parents may take a more parent-centred approach. This may reflect their high expectations of their child's attainment. As stated previously, family interactions occur within differential cultural contexts (García Coll et al., 1996). Within the context of the Bioecological Systems model (Bronfenbrenner, 1976; Bronfenbrenner & Morris, 2007; Vélez-Agosto et al., 2017) with culture embedded within the proximal level, it is apparent how cultural norms around, for example, the value placed on education may directly influence the nature of the interactions between parents and children within the home. This is in line with Vélez-Agosto et al. (2017) updated framework of the model, with culture having direct and substantive influence on child development. Our findings may indicate this direct impact of cultural values and norms on parents' expectations and attitudes, replicating previous research in the United States with Hispanic/Latine mothers and caregivers (Melzi et al., 2022; Mendelsohn et al., 2023).

The "Interactions Related to Reading and Mathematics" (Mexico) theme also discusses how participants would support, engage and correct their children during mathematical activities at home. This overlaps with "Parent–child Interaction" (NI) and "Interactions for Learning Mathematics" (Cuba), although there was a focus on interactions in both the domains of reading and mathematics in the Mexican caregiver data, whilst there was more of a focus on mathematics in the Cuban caregiver's data. Participants in all countries discussed their approaches to engaging their children in mathematical activities and scaffolding their children's learning (Berk & Winsler, 1995). Participants also displayed insight into the delivery of mathematical content when children may be finding concepts difficult to grasp, with a common approach of using everyday objects to visually demonstrate mathematical concepts to try to make learning easier and fun through play. This kind of approach is in fact evidence-based and commonly occurs within educational settings when using concrete manipulatives (Educational Endowment Foundation, 2020). Therefore, parents/caregivers report sensitively engaging with their children in learning opportunities and spontaneously engaging in approaches that would be regarded as evidence-based.

4.1 | Strengths and limitations

These findings reveal interesting country-specific approaches that caregivers engage in with their children in the HME, which can only be first identified through qualitative approaches. The current study highlights that qualitative methods are a necessary step in research, which can lead to informing questionnaire development or amendment of existing resources to ensure that methods are context relevant. This approach should achieve increased face validity in future amended or developed measurement tools. This qualitative, cross-country research is important and unique, as this approach to understanding the views and experiences of parents/caregivers in relation to learning in the home, the HME, is underdeveloped (Hornburg et al., 2021). Therefore, by taking this qualitative approach to understanding the HME across culturally diverse samples, some consistent views, experiences and attitudes to the HME were identified. However, distinct cultural norms were also displayed, particularly in relation to children's attitudes to mathematics and the value that caregivers place on mathematics (Hu et al., 2018). This study highlights that some aspects of the HME can be regarded as "universal" (e.g., all participants across United Kingdom, Mexico and Cuba utilised physical objects to demonstrate mathematical concepts). We consider universalism as consistencies that are not country dependent. Therefore, in a practical sense, these findings suggest that some measurement tools of the HME may be applied across different country settings—forming a foundation of questions to ask participants. However, these tools may also require amendment to ensure that they are appropriate to different country settings and reflect the true nature of the HME in these contexts.

The findings of this study indicate that Mexican and Cuban households may offer more formal approaches to learning than those in NI. However, it should be noted that data in Mexico and Cuba were collected during the period of the COVID-19 pandemic, though these countries were not in a period of full restrictions at the time and children were attending various settings outside of the home. There is the possibility that lockdown periods and school closures may have led to greater collaboration between caregivers and schools (OECD, 2020) and this may have influenced parenting behaviour. Specifically, schools increasingly provided home learning resources; these may have had a trickle-down effect in influencing how caregivers generally approached mathematical activities in the home. Therefore, our findings should be carefully considered in this context.

It should also be noted that data were collected in Mexico with parents/caregivers whose children attended public preschools and nurseries belonging to the IMSS. These settings curriculum is aligned with the objectives of the Secretariat of Public Education for preschool-aged children. However, although the IMSS has the greatest percentage of affiliated workers (51.03% nationally and 64.74% in Chihuahua), there are other subsidised programmes in Mexico such as child day care institutions through the ISSSTE Instituto de Seguridad Social y Servicios Sociales de los Trabajadores del Estado (Mexican Institute for Social Security and Services for the Workers of the State; national 7.74%, Chihuahua 5.47%), Petróleos Mexicanos (Mexican Petroleum Company), Defence and Marine Ministry (both presented together national: 1.29%, Chihuahua 0.34%). Further, a high percentage of the Mexican population do not have access to subsidised programmes (i.e., without national 39.94%, Chihuahua 29.45%). Therefore, the findings may not reflect the broader Mexican population.

Finally, it is important to note that there was a difference in male-to-female ratio between the samples, with Mexico including only 23% female participants and Cuba 55%. However, the similarities in the results across countries reported here do not suggest a specific influence of gender in the analysed dimensions. Future studies could further explore the impact of gender in the HME. This is particularly pertinent in the context of the current study wherein participants' demographics were skewed towards higher levels of SES and educational experience than population norms. Therefore, it is important to reflect on our findings in acknowledging the distinct geographical areas in Mexico and Cuba in which the data were collected and the demographic backgrounds of the samples.

5 | CONCLUSION

This study offers a unique contribution to the literature by providing in-depth information for understanding the different perspectives of the HME for 3- to 5-year-olds in Mexico and Cuba. The findings highlighted the fact that some home numeracy practices may be universal in nature while there are also differences and similarities across countries in mathematical experiences, attitudes and teaching practices occurring in the home, offering a framework for future research. The data also emphasise the importance of qualitatively exploring a construct across different countries. This study should be used to strengthen quantitative measurement developments that reflect specific country-dependent attitudes, expectations and activities.

AUTHOR CONTRIBUTIONS

Abbie Cahoon: Conceptualization; formal analysis; funding acquisition; investigation; methodology; project administration; resources; supervision; writing – original draft; writing – review and editing. **Yanet Campver:** Data curation; formal analysis; writing – original draft. **Nancy Estévez:** Conceptualization; data curation; formal analysis; funding acquisition; investigation; project administration; resources; supervision; writing – original draft; writing – review and editing. **Carolina Jiménez Lira:** Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; supervision; writing – original draft; writing – review and editing. **Daniela Susana Paz García:** Data curation; formal analysis; investigation; methodology; project administration; resources; writing – original draft; writing – review and editing. **Elia Veronica Benavides Pando:** Data curation; formal analysis; investigation; methodology; project administration; resources; supervision; writing – original draft; writing – review and editing. **Victoria Simms:** Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; supervision; writing – original draft; writing – review and editing.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

N/A

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ENDNOTE

[1] All transcriptions were translated from Spanish to English by a professional translator. All Spanish speaking co-authors checked these translations for accuracy.

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