



# Mathematical Development in Early Childhood: Challenges in Urban-Marginal Contexts of Guayaquil

Desarrollo matemático en la primera infancia: retos en contextos urbano-marginales de Guayaquil

Daniel Fabricio Quinde Chalén\*, Katherine Lisbeth Alcívar Pazmiño\*, Maritza Catherine Vallejo Palacios\*

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\* Magíster en Desarrollo Temprano y Educación Infantil  
Universidad Casa Grande  
dquinde@casagrande.edu.ec

https://orcid.org/0009-0005-1898-9165  
\* Magíster en Neuropsicología Mención en  
Neuropsicología del Aprendizaje  
Universidad Internacional del Ecuador  
kaalcivarpa@uide.edu.ec  
https://orcid.org/0009-0006-3868-9212

\* Magíster en Pedagogía  
Universidad de Guayaquil  
Facultad de Filosofía, Letras y Ciencias de la Educación  
maritza.vallejop@ug.edu.ec  
https://orcid.org/0000-0003-3884-6039

## Abstract

This study analyzes the conditions and challenges faced by young children in the development of logical-mathematical thinking in marginal urban contexts in Guayaquil, Ecuador. Using a qualitative approach and a multiple case study design, data were collected through interviews, non-participant observation, and document review in three educational centers: a Centro Infantil del Buen Vivir (CIBV), a public preschool, and a community early care center. The results show that mathematical stimulation in the classroom is limited and based mainly on memorization activities, without structured teaching planning. Family participation varies according to the center, and although valuable efforts by caregivers are identified, these are hampered by a lack of resources, time, and training. The availability of teaching materials is low, and specific teacher training in early mathematical development is insufficient. Despite these limitations, a strong emotional bond between educators and children is observed, which constitutes a favorable basis for learning. It is concluded that early childhood mathematical development in vulnerable contexts requires intersectoral attention that articulates educational, social, and community efforts. The study highlights the need to strengthen teacher training, provide accessible materials, and promote family involvement as fundamental pillars for improving mathematical learning opportunities from the earliest years of life.

**Keywords:** early childhood, mathematical development, early education, vulnerable contexts.

## Resumen

Este estudio analiza las condiciones y desafíos que enfrentan los niños y niñas de primera infancia en el desarrollo del pensamiento lógico-matemático en contextos urbano-marginales de Guayaquil, Ecuador. A partir de un enfoque cualitativo y un diseño de estudio de caso múltiple, se recogieron datos mediante entrevistas, observación no participante y revisión documental en tres centros educativos: un Centro Infantil del Buen Vivir (CIBV), una unidad educativa fiscal con nivel inicial, y un espacio comunitario de atención temprana. Los resultados muestran que la estimulación matemática en el aula es limitada y se basa mayormente en actividades memorísticas, sin una planificación didáctica estructurada. La participación familiar varía según el centro, y aunque se identifican esfuerzos valiosos por parte de cuidadores, estos se ven obstaculizados por la falta de recursos, tiempo y formación. La disponibilidad de materiales didácticos es baja, y la formación docente específica en desarrollo matemático temprano resulta insuficiente. A pesar de estas limitaciones, se observa un fuerte vínculo afectivo entre educadoras y niños, lo cual constituye una base favorable para el aprendizaje. Se concluye que el desarrollo matemático en la primera infancia en contextos vulnerables requiere una atención intersectorial que articule esfuerzos educativos, sociales y comunitarios. El estudio plantea la necesidad de fortalecer la formación docente, proveer materiales accesibles y promover el involucramiento familiar como pilares fundamentales para mejorar las oportunidades de aprendizaje matemático desde los primeros años de vida.

**Palabras clave:** primera infancia, desarrollo matemático, educación inicial, contextos vulnerables.

## Introduction

The development of logical-mathematical thinking in early childhood is one of the fundamental pillars for future learning in science, problem solving, and abstract reasoning in adult life. Numerous studies have shown that early mathematical skills not only predict academic performance at higher levels, but are also closely linked to overall cognitive development, self-regulation, and decision-making ability (Clements & Sarama, 2021; Duncan et al., 2007). Indeed, learning mathematical concepts such as classification, counting, seriation, comparing quantities, spatial orientation, and pattern recognition begins before formal schooling and is built through interaction with the environment, play, and adult-mediated mathematical language.

International evidence has highlighted that inequalities in access to quality mathematical learning experiences begin in the early years of life and tend to deepen if not addressed in a timely manner. According to the Organization for Economic Cooperation and Development (OECD, 2020), achievement gaps in mathematics between students from different socioeconomic backgrounds can already be observed at age five and persist or widen throughout the educational

process. This reality is particularly critical in Latin American countries, where structural poverty, informal employment, low maternal education, and poor housing conditions negatively affect opportunities for cognitive and social stimulation in the early years of life (UNESCO, 2022).

Ecuador is no stranger to this problem. Despite regulatory advances in comprehensive child development and early childhood education, deep inequalities persist in marginal urban areas, particularly in cities such as Guayaquil, where a high proportion of the child population is vulnerable. According to the National Institute of Statistics and Census (INEC, 2022), nearly 28% of children under five in peripheral urban areas live in multidimensional poverty, which implies simultaneous restrictions in health, nutrition, access to services, adequate housing, and early stimulation. Monte Sinaí, Bastión Popular, Nueva Prosperina, and El Fortín are some of the areas where these conditions are most evident, limiting the full development of children.

Mathematical development in early childhood does not only depend on the formal education system, but is also deeply determined by parenting practices, families' cultural capital, the resources available in the home, and the opportunities that the immediate environment offers for exploring, counting, classifying, comparing, or solving everyday situations. So-called “math talk”—the use of numerical and spatial language in daily interactions between adults and children—has been recognized as a powerful tool for strengthening these skills from birth (Gunderson & Levine, 2011). However, it is much more prevalent in households with high levels of education and income, which accentuates the gaps between those who enter school with a solid foundation in mathematical thinking and those who do so with significant gaps.

In contexts of social exclusion, such as those found in marginal urban areas of Guayaquil, these gaps often go unnoticed in early childhood education, where activities focused on motor skills or artistic expression are frequently prioritized, intentionally and systematically neglecting the development of logical-mathematical thinking (Cevallos & Zúñiga, 2021). In addition, limitations in the specific training of early childhood teachers, the limited availability of appropriate teaching materials, institutional overload, and the lack of support for families are additional obstacles to strengthening these skills.

Furthermore, recent research indicates that chronic child malnutrition, which affects a significant percentage of Ecuadorian children living in poverty, has a direct impact on higher cognitive functions, including working memory, sustained attention, and logical reasoning, all of which are essential components of mathematical thinking (Martínez & Peralta, 2020). In this regard, addressing early childhood mathematical development from a cross-sectoral approach—

that considers health, nutrition, education, and social protection—is essential to achieving sustainable and equitable progress.

Furthermore, in the Ecuadorian context, early childhood care has become increasingly important in regulatory and policy frameworks in recent years. The Constitution of Ecuador (2008), in Article 44, establishes that the State, society, and the family have an obligation to guarantee the rights of children from conception, prioritizing their comprehensive development and access to quality early childhood education. Similarly, the Code on Children and Adolescents (2003) and the National Development Plan “Toda una Vida” (A Whole Life) have emphasized the need to coordinate public policies that strengthen early childhood development, especially in the most socially vulnerable sectors.

One of the most significant advances in this field has been the implementation of the national comprehensive child development policy through services such as the Children's Centers for Good Living (CIBV) and the Growing with Our Children (CNH) program, led by the Ministry of Economic and Social Inclusion (MIES). These strategies seek to guarantee educational, nutritional, emotional, and social support for children aged 0 to 5, with an emphasis on urban-marginal and rural sectors (MIES, 2021). However, multiple evaluations have pointed out that these policies face significant challenges in terms of coverage, quality of care, staff training, infrastructure, and coordination with the formal education system (Cedeño & Moreira, 2022).

In particular, early childhood education in Ecuador—which comprises sublevel 1 (0 to 3 years) and sublevel 2 (3 to 5 years)—has made significant regulatory progress but continues to suffer from deep structural gaps. According to data from the Ministry of Education (2022), national coverage in sublevel 2 reaches only 49% of the target population, and in sublevel 1, it drops to 12%. In marginal urban areas of Guayaquil, these figures are even more critical, due to the shortage of public institutions offering early childhood education, low investment in infrastructure for children, and families' difficulties in accessing quality alternative care services. In addition, many public educational institutions offering early childhood education operate with limited resources, inadequate physical spaces, and high teacher turnover.

The training of educators also represents a challenge. Although the legal framework requires early childhood education teachers to have specialized degrees in early childhood education or preschool education, in practice many institutions hire staff without specific training or with minimal training in early cognitive development. This has a direct impact on the implementation of appropriate pedagogical strategies for strengthening mathematical thinking in early childhood. Recent studies in Ecuador have shown that early childhood education teachers tend to focus on reproductive or memorization activities,

with little incorporation of playful, exploratory, or problem-solving approaches (Viteri & Alvarado, 2021).

In areas such as Monte Sinaí, considered one of the largest informal settlements in the country, these problems are exacerbated by the precarious environment, limited institutional provision, and lack of technical and pedagogical support for community centers that partially fill the gap left by the state.

## Materials and methods

The methodology adopted for this study is based on a descriptive-interpretative qualitative approach, which responds to the need to explore in depth the conditions that influence the development of mathematical thinking in young children living in marginal urban contexts in Guayaquil. This approach is justified by the fact that the phenomenon addressed cannot be explained solely on the basis of quantitative data or objective measurements, but must be understood from the everyday experience of educational actors, the analysis of family environments, the pedagogical practices observed, and the availability of both material and symbolic resources that enable—or limit—the emergence of logical-mathematical thinking in early childhood. The nature of the problem, being deeply rooted in contextual, social, and cultural aspects, requires a flexible and comprehensive methodological design that allows access to the meanings, perceptions, and experiences that underlie educational, family, and community practices.

The design adopted was that of a multiple case study, which allowed for the comparative investigation of three educational spaces located in vulnerable sectors of the city: a Children's Center for Good Living (CIBV) located in Monte Sinaí, a public school with an early childhood program in the El Fortín sector, and a community space for informal childcare in the Nueva Prosperina area. These three cases were chosen through intentional sampling based on criteria of contextual relevance, institutional diversity, previous experience in early childhood care, and willingness to participate in the research. The three spaces represent a heterogeneous but coherent sample, as they reflect different approaches to education in territories with common characteristics such as structural poverty, limited access to basic services, high population density, low educational attainment among responsible adults, and psychosocial vulnerability of families. The multiple case study allowed us to identify common patterns in the phenomenon, as well as nuances specific to each institutional space.

The study participants were selected through theoretical sampling, seeking to gather the voices of those actors who interact directly with children and have in-

depth knowledge of their contexts and trajectories. In total, 21 key informants participated, divided into three groups: six teachers or child development promoters linked to the spaces observed, twelve mothers or primary caregivers of children between the ages of three and five, and three directors or pedagogical coordinators from the participating institutions. The inclusion of diverse actors allowed for the triangulation of perspectives and enriched the analysis of the phenomenon from different levels of observation: the classroom, the home, and institutional management. The inclusion criteria were clear: direct experience in accompanying preschool-aged children, a minimum of two years of permanence in the center or community, and informed consent to participate in interviews and observations.

Data collection was carried out using three complementary qualitative techniques: semi-structured interviews, non-participant observation, and document review. Semi-structured interviews were conducted in person with teachers, caregivers, and administrators, using a flexible guide that allowed for exploration of key aspects such as mathematical stimulation practices, learning routines, difficulties observed in children, use of teaching materials, the role of the family in cognitive development, and expectations regarding the learning of numerical concepts in early childhood. The interviews, which lasted an average of 45 minutes, were audio recorded with prior consent and transcribed in full for later analysis. At the same time, non-participant observation sessions were carried out in the three centers, during which the researcher remained as an external observer in regular class activities, free play times, and other everyday interactions. The observation focused on recording spontaneous behaviors of children related to mathematical thinking (such as counting, comparing, classifying), as well as the pedagogical strategies used by adults to promote this learning. Special attention was paid to child-adult interactions, the layout of the educational environment, and the quality of the materials used. The observations were documented through field notes rich in descriptive and reflective detail.

The third technique used was document review, which provided access to complementary information on the functioning of the institutions and their pedagogical approaches. Teaching plans, internal reports, educational materials developed by teachers, and official documents from the Ministry of Economic and Social Inclusion (MIES) and the Ministry of Education of Ecuador related to comprehensive child development and early childhood education were analyzed. This review allowed us to contrast institutional discourse with observed practice and helped to situate the study within the current regulatory framework.

In terms of the ethical treatment of the research, the fundamental principles established by the Declaration of Helsinki and the ethical codes for educational research were complied with. Each adult participant was given an informed

consent form explaining the objectives of the study, the voluntary nature of their participation, the protection of their identity, and the academic use of the information collected. In the case of the children observed, no interviews or direct interactions were conducted, and their presence was addressed solely through contextual observation, ensuring anonymity and respect for their integrity at all times. Likewise, written authorization was requested from the institutional heads of each center to conduct visits, observations, and interviews within their spaces.

The data collected was analyzed through a thematic coding process, using Atlas.ti software to facilitate the organization, segmentation, and interpretation of the information units. Initially, a comprehensive reading of the transcripts and field notes was carried out, identifying emerging categories related to the study objectives. Subsequently, open coding was developed, which gave rise to subcategories such as “mathematical stimulation at home,” “low-cost materials,” “nutritional deficits,” “caregiver role,” and “pedagogical interaction,” among others. These categories were grouped into broad thematic areas and then triangulated with the information obtained from institutional documents. This analysis process generated significant findings on the situation of mathematical development in early childhood in socially excluded environments, with rich empirical evidence and contextualized examples. The interpretation was aimed at constructing a comprehensive narrative of the barriers, opportunities, and proposals that emerged from the actors themselves who live with this reality.

## Results

The analysis of the data obtained in the three centers observed—the Monte Sinaí Good Living Children's Center, the El Fortín Public Education Unit, and the Nueva Prosperina Community Space—reveals a complex and multifactorial situation surrounding the development of mathematical thinking in children aged 3 to 5 in urban-marginal contexts. Based on interviews with teachers, caregivers, and administrators, as well as non-participant observations, five central themes were identified: mathematical stimulation in the classroom, family participation, availability of teaching resources, quality of child-adult interaction, and development of basic numerical skills.

With regard to mathematical stimulation in the classroom, the three centers show low to moderate levels of pedagogical intentionality in this area. At the CIBV in Monte Sinaí, the average score observed was 2.75 out of 5, slightly higher than that of the El Fortín Educational Unit (2.31) and the Nueva Prosperina Community Space (2.04). These values reflect a practice focused mainly on repetitive routines, number songs, and rote counting, without delving into the understanding of concepts such as quantity, classification, or seriation. The

activities observed often lack a planned teaching sequence that promotes logical reasoning, and printed worksheets with no connection to the child's environment are often used.

In terms of family participation, marked differences were found between the centers. While Monte Sinaí and Nueva Prosperina showed active participation by caregivers in classroom activities, with average scores of 3.38 and 3.42, respectively, participation at El Fortín was very limited (1.15). The interviews revealed that most mothers and grandmothers value education but face barriers such as lack of time, long working hours, and lack of knowledge about how to support math learning at home. However, valuable practices were identified, such as the use of household objects for counting (plates, buttons), the organization of traditional games with quantifiable elements, and storytelling involving spatial or sequential concepts.

The availability of teaching resources is a common challenge in all three centers. Although the average scores were moderately acceptable (between 3.18 and 3.49), the type of materials available is limited mainly to posters, illustrated books, and some basic games. The use of concrete manipulatives (blocks, geometric shapes, rulers, among others) is scarce and in many cases nonexistent. In the community space in Nueva Prosperina, educators showed greater creativity in adapting recycled materials for educational purposes, such as bottle caps, popsicle sticks, and cardboard boxes. However, these initiatives tend to depend on individual effort rather than a systematic institutional policy.

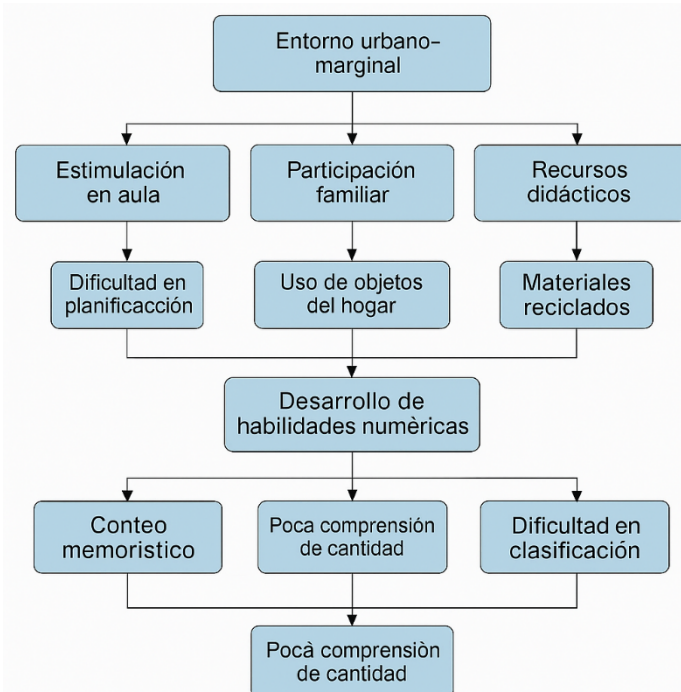
In terms of child-adult interaction, high levels of warmth and emotional support were observed in all three centers, with an average score of 4.08 in both Monte Sinaí and El Fortín, and 3.38 in Nueva Prosperina. Educators establish strong emotional bonds with children and are attentive to their needs, which is a positive foundation for learning. However, the quality of interactions from a mathematical development perspective has limitations. In most cases, the questions asked of children do not promote reasoning or reflection, and everyday situations are not used to introduce numerical or spatial concepts. There was little "mathematical talk" during routines and little verbal mediation to stimulate logical thinking.

Finally, the analysis of basic numeracy skills shows worrying results. In Monte Sinaí and Nueva Prosperina, average scores were low (2.31 and 2.36, respectively), while in El Fortín, higher performance was observed (3.42), possibly related to the higher academic training of the teaching staff. In general, children can count from 1 to 10 by rote, but they have difficulty associating quantities with numbers, making comparisons, establishing patterns, or solving simple classification problems. The qualitative assessment suggests that these difficulties are associated with a lack of previous experience at home, limited

verbal stimulation, and a scarcity of materials that facilitate the manipulation and exploration of abstract concepts.

An emerging finding of the study is the importance of local initiatives and the commitment of some community actors, especially in the center of Nueva Prosperina, where, despite the absence of formal resources, education is promoted that is close to the reality of the child, with activities based on play, storytelling with quantifiable elements, and family participation. This approach has proven effective in introducing basic mathematical concepts in a natural way, although these practices still need to be systematized and strengthened with training and technical support.

**Figure 1.** Conceptual network of factors that influence the development of numeracy skills in early childhood in urban-marginal contexts in Guayaquil.



In summary, the results show that early childhood mathematical development in marginal urban areas of Guayaquil is affected by multiple interrelated factors: lack of specialized teaching planning, poor teacher training, material limitations, and low involvement of some households. However, opportunities for improvement were also identified in pedagogical creativity, the richness of the sociocultural environment, and the transformative potential of family participation. These findings support the need for more comprehensive public policies that prioritize continuing education in early mathematics education, promote the production and distribution of accessible materials, and recognize the key role of the community in building logical-mathematical knowledge from an early age.

## Conclusions

The study conducted in three schools located in marginal urban areas of Guayaquil—Monte Sinaí, El Fortín, and Nueva Prosperina—has revealed a series of structural, pedagogical, and sociocultural conditions that significantly limit the development of logical-mathematical thinking in early childhood. The results confirm that the acquisition of basic numerical skills, such as counting with understanding, classification, and comparison of quantities, is hampered by a combination of factors ranging from institutional precariousness to low family participation and limited training of educational actors.

One of the most relevant findings is the lack of pedagogical intentionality in the approach to mathematics in early childhood education, especially in contexts of poverty. Although the national curriculum establishes logical-mathematical thinking as a fundamental axis of child development, in practice, the strategies observed are limited to mechanical counting, repetition of numerical sequences, and the execution of activities without meaningful connection to the child's environment. When it exists, lesson planning rarely includes problem-solving situations or logical or manipulative games that allow children to explore, infer, and construct concepts from their own experience.

Likewise, the family environment, although committed in many cases, faces structural and cultural barriers to becoming an active agent in mathematical stimulation. Work overload, the low educational level of responsible adults, and limited awareness of the importance of “mathematical talk” hinder the incorporation of numerical activities into daily routines. However, valuable experiences were identified in which families, with minimal resources, adapt household objects and traditional games to introduce basic concepts, demonstrating that poverty is not an absolute impediment, but rather a context that requires adapted strategies and sustained support.

At the institutional level, the availability of adequate teaching resources was another limiting factor. Most of the centers observed operate with basic and limited materials, which restricts the possibility of offering rich, concrete, and multisensory experiences. Although creativity was evident in some community spaces, such as in Nueva Prosperina, these initiatives depend more on individual effort than on a coordinated institutional policy. It is therefore urgent that public early childhood programs include specific components for mathematics education and technical training in the design of low-cost play and manipulative materials.

In contrast to these weaknesses, significant strengths were identified in the emotional quality of child-adult interactions. The educators observed showed high levels of sensitivity, emotional support, and ability to establish secure bonds with children, which is a fundamental basis for learning. However, these

interactions, while affective, are not always mediated by content that promotes cognitive or numerical development. This highlights the need for technical and pedagogical support to enable educators to transform these relationships into opportunities for structured learning.

From a broader perspective, the study's results reinforce the theoretical approaches of Piaget and Vygotsky, confirming that logical-mathematical development is not an exclusively maturational process, but rather a construction that depends on the child's active interaction with their physical, social, and symbolic environment. In marginal urban contexts, where these environments are limited or fragmented, the role of the adult mediator—whether teacher, caregiver, or family member—becomes even more crucial. Therefore, intervention strategies should focus not only on the child, but also on the training, awareness, and support of the adults who make up their microsystem.

Another important element derived from this study is the need to rethink teacher training in early childhood education. Although the curriculum establishes clear objectives for the development of logical thinking from an early age, there is a significant gap between the normative document and actual practices. It is essential to incorporate specific methodological tools for early mathematical development into the initial and continuing training of educators, including playful approaches, the use of manipulative materials, problem solving, and the promotion of mathematical language. This training must be contextualized, taking into account the social and cultural realities of the sectors in which teachers work.

Finally, the study concludes that the promotion of logical-mathematical thinking in early childhood in contexts of social exclusion cannot be addressed in a fragmented manner. An intersectoral approach is required that articulates education, health, social development, and urban planning policies in order to guarantee minimum conditions for learning: adequate nutrition, safe spaces, access to materials, quality educational services, and support for families. Equity in cognitive development begins at birth, and the state has a responsibility to ensure that all children, regardless of their place of birth, have the same opportunities to build the foundations of their logical thinking from the earliest years of life. In short, early mathematical development in marginal urban areas of Guayaquil is conditioned by multiple structural barriers, but also by a set of educational opportunities that, if recognized, strengthened, and systematized, can significantly contribute to reducing learning gaps from early childhood. It is therefore necessary to move towards an inclusive, contextualized, and equitable educational model that allows children in these sectors not only to learn to count, but also to have the necessary conditions to think, reason, and transform their reality.

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