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The Perspective of Numbers from the Emotional Viewpoint of Early Childhood Education Teachers

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Abstract: The objective of this study is to examine the impact of initial training on the pedagogical practices of early childhood educators through an analysis of mathematics teachers' specialized knowledge present in their narratives on the teaching of numbers. This qualitative research, which employs a phenomenological approach, is situated within the field of mathematics education and teacher training. The study is based on the analysis of oral histories of a group of seven preschool teachers, with a particular focus on the teaching of numbers to children between the ages of two and six. Upon conclusion of the study, an analysis of the pedagogical experiences of the cases under examination, in consideration of the categories and subcategories of the mathematics teachers' specialized knowledge, the curriculum, and the emergent, leads to the conclusion that teachers tend to rely more on their conceptions, beliefs, and emotions about number, derived from their experiences as students and mathematics teachers, than on the disciplinary knowledge of early childhood educators.



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Keywords: learning environments, dynamic software, rubric, function, problem solving.

从幼儿教育教师的情感视角看数字

摘要: 本研究的目的是通过分析数学教师在数字教学叙述中所体现的专业知识, 考察初始培训对幼儿教育工作者教学实践的影响。这项定性研究采用现象学方法, 属于数学教育和教师培训领域。这项研究基于一组七名幼儿园教师口述历史的分析, 特别关注对两到六岁儿童的数字教学。研究结束后, 对所研究案例的教学经验进行分析, 考虑到数学教师专业知识的类别和子类别、课程和新兴事物, 得出的结论是, 教师往往更多地依赖他们对数字的概念、信念和情感, 这些概念、信念和情感源于他们作为学生和数学教师的经历, 而不是幼儿教育工作者的学科知识。

关键词: 学习环境、动态软件、评分标准、功能、问题解决

1. Introduction

In Colombia, the Early Childhood Education is mandatory for only a single grade. The objective is to facilitate the comprehensive development of human beings through active participation in a meaningful and relevant context. However, an analysis of the curriculum and regulations reveals that these spontaneous relationships are perceived as preconceptions in various disciplinary fields [1].

In the context of mathematics, these preconceptions are of paramount importance for the planning and design of initial, introductory, or stimulation activities linked to the attributes of objects, including size, distance, location, equivalence, orientation, and inclusion. These activities are centered on visualization and tracing, with the symbolic representation of numbers positioned as the primary objective of teaching and learning mathematics in children between the ages of three and six [2].

In regard to the mathematical training of educators, the Colombian legal framework, particularly the General Education Law and the regulations governing undergraduate programs in education and training in early childhood pedagogy, stipulates that teachers must receive training in professional competencies centered on the education and comprehensive development of children at an early age [1].

According to the initial training, the professional knowledge that teachers use in their pedagogical practice should interpret diverse situations in educational contexts [3], an idea supported by [4]. From this perspective, he suggested the need to transcend practices based solely on the mastery of disciplinary knowledge, integrating other knowledge and teachers' conceptions [5].

Initial training in mathematics for those pursuing a career in Bachelor's Degree Early Childhood Education is of paramount importance. This study analyzes this aspect in the context of oral histories [7] because teachers' conceptions exert a significant influence on the teaching of mathematical concepts. An

analysis of teachers' experiences and their understanding of mathematics, as well as their pedagogical approaches, within the context of their professional practice, while still students or graduates of degree programs under the guidance of a tenured teacher in diverse institutional settings where early childhood care is provided, enables us to gain insight into how these beliefs are associated with the conceptual didactic structures through which they comprehend concepts such as numbers, based on their lived experiences [8].

The following criteria have been established for the selection of the object of study, namely, "initial training in mathematics for early childhood education teachers"; the relationship with undergraduate training programs is of interest as the curriculum review reveals the subjects that guide initial mathematics training, whether from the mathematical disciplinary field and/or from the didactic and pedagogical field. The condition of the training status, whether a student or a graduate of the degree, is a significant factor to consider. The experience of educational practices as a student and graduate differs considerably with respect to the relationship with professors. This can be broken down into two key areas: first, autonomy in the design and implementation of didactic strategies, and second, decision-making in the face of emerging situations. In the context of emerging situations with children in their care, those who have not yet completed their initial training are primarily child carers. This role entails a different approach to the mathematical concept of numbers, where the teacher's role is that of a career.

To define the parameters of the study and facilitate analysis, a methodological framework is constructed from Didactic Content Analysis [7], adapted to the mathematical didactic curriculum of a mathematics didactics course in a Bachelor's degree program in early childhood pedagogy [9]. This framework is based on mathematics curricular guidelines [10], basic standards of mathematical competence [11], and basic learning rights of mathematics [12].

The program was delivered at a public higher education institution in southwestern Colombia. The majority of the students were women between the ages of 16 and 40, hailing from rural regions within the departments of Cauca, Nariño, Chocó, and the surrounding Valle del Cauca. Despite their rich cultural heritage, these students face considerable socioeconomic and personal challenges, particularly in the realm of mathematics. Through their training in early childhood pedagogy, they aspire to provide comprehensive support to younger members of their communities through pedagogical practices [13].

The pedagogical practice exhibited by preschool teachers in the initial training classroom for mathematics presents a research challenge with regard to questioning. Specifically, what is the influence of initial training on the narrated practices of teachers who have undergone a degree program in early childhood pedagogy for teaching numbers at this level? It is evident that all teachers undergoing initial mathematics training must receive instruction in both mathematical and pedagogical didactic knowledge. However, the oral histories that these teachers present during didactics and mathematics courses tend to prioritize their personal conceptions about teaching and learning mathematics.

Some results [14] indicate that mathematics teachers draw on their own experiences in teaching and learning mathematics to address pedagogical challenges that arise in the classroom. This research employs the model of analysis of mathematics teachers' specialized knowledge proposed in [15] to examine the professional knowledge of early childhood teachers. This model focuses on the conceptual frameworks teachers use to integrate disciplinary knowledge in mathematics with pedagogical knowledge.

This model, in conjunction with didactic curricular content analysis [16] based on the theories of the organizers of the mathematics curriculum [17], enables the formation of categories and subcategories for the analysis of teacher narratives. This approach was developed through interviews with an undergraduate student in Early Childhood Education, with a focus on the review of normative and curricular documents on the teaching and learning of numbers at the preschool level and from the perspective of the initial training of early childhood pedagogy graduates.

At the conclusion of the study, it was observed that the narratives of the pedagogical practices of the selected teachers revealed a connection between their personal experiences as students and mathematics teachers. These experiences are centered on their conceptions of teaching and learning mathematics, considering the socio-affective and emotional components that influence their role as caregivers in their educational contexts. In these accounts, disciplinary and pedagogical knowledge is presented in a limited way, and the development of the mathematics

curriculum is oriented towards standardization within contemporary pedagogical frameworks. This suggests the need to redefine the mathematics curriculum for the initial teacher education.

2. Theoretical Framework

2.1. Bachelor's degree in early childhood education

Higher education institutions and Colombian regulations [18] require that early childhood education professionals possess a comprehensive understanding of the following: the fundamentals of early childhood pedagogy, child development, teaching methods and strategies, curriculum design, educational assessment, information and communication technologies, educational inclusion and diversity, play and learning in early childhood, professional practices in early childhood education, and educational research and didactics in different learning areas.

2.2. Specialized knowledge of the mathematics teacher

This analytical model articulates the disciplinary knowledge of mathematics with pedagogical knowledge through teachers' conceptions of the teaching and learning of mathematics. It establishes three subdomains for understanding the mathematical disciplinary knowledge domain: knowledge of the subject, mathematical structure, and mathematical practice. Additionally, it identifies two subdomains for didactic knowledge of the content, namely, knowledge of the characteristics of mathematics learning and knowledge of mathematics learning standards [19].

2.3. Didactic Curricular Analysis of Content (DCAC) for the number in Early Childhood Teaching

Based on the theory of curriculum organizers and the reflections of the pedagogical practice of teachers [20], the didactic analysis of content as well as the specialized knowledge of the teacher who teaches mathematics are tools that the teacher acquires in the initial training of the graduate.

The didactic analysis of content can be adapted according to selected theories. Teachers who teach numbers in early childhood education should consider conceptual elements of history, cognitive epistemology, and phenomenology, among others, in the framework of didactics and mathematics curriculum. The following section presents a didactic curricular analysis of the content of natural numbers from the perspective of a potential teacher of number concepts in early childhood education who has undergone initial training in didactic mathematics (Figure 1).

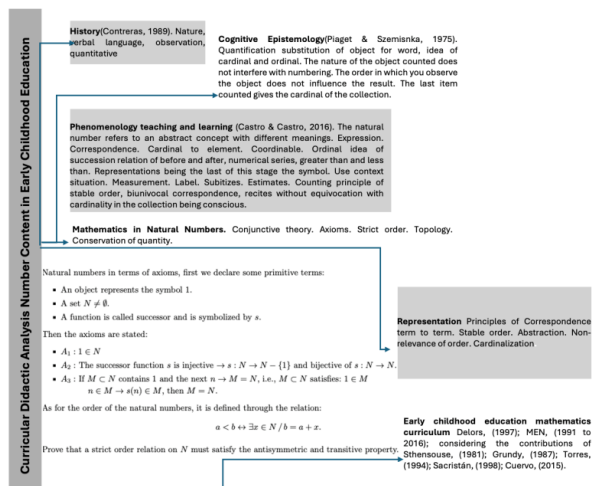


Figure 1. Didactic curricular content analysis
(Developed by the authors)

The number is perceived in relation to the attributes of the bodies, biunivocal correspondence, and associations [21]. It is inherent in counted, ordered, and grouped object [22]. In terms of representation, it presupposes the principles of term-to-term correspondence, stable order, abstraction, order relevance, and cardinalization [23].

From an interdisciplinary perspective, numbers can be conceptualized as a network of ideas that teachers construct theoretically and procedurally. This network is dynamic, and adapts to the context in which it is applied. However, it is essential that this construct be subject to constant reflection in pedagogical practice and initial training. In accordance with professional knowledge of mathematics didactics, the teacher presents a conceptual procedural structure for teaching numbers in early childhood education.

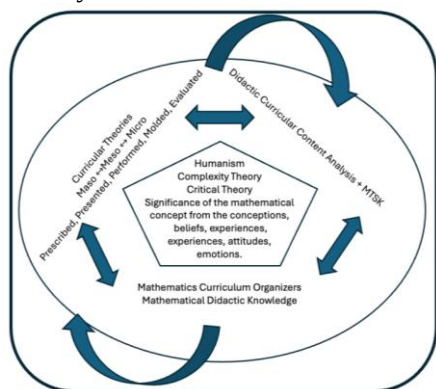


Figure 2 Theoretical Conceptual structure of the professional knowledge of the teacher who teaches mathematics (Developed by the authors)

This structure is based on the research conducted by the DCAC+MTSK, which provides insights into the teaching of numbers in pre-school. The structure encompasses the domains shown in Figure 2.

3. Methodology

This research was qualitative [23] and was

developed using a phenomenological approach [24] through a case study [25]. Its objective is to interpret the narratives of teachers in initial training on the teaching of numbers at the preschool level, using the theoretical frameworks of didactic curricular analysis of content and specialized knowledge for the teaching of mathematics.

In light of the intricate nature of the problem and the heterogeneity of the sources, a multimethod approach was employed to facilitate triangulation [26]. The objective was to ascertain the impact of early childhood education teachers' initial mathematics training on their pedagogical practices. The interpretation of the narratives of the participating teachers regarding the teaching of numbers at the preschool level, employing the conceptual theoretical frameworks of the didactic curricular analysis of content, and specialized knowledge for the teaching of mathematics, designed or adapted for analysis in the study, are their own constructions and the results of the research.

The process commences with an examination of the mathematics curriculum, encompassing the undergraduate program in early childhood pedagogy and the microcurriculum of the subject Didactics of Mathematics. Subsequently, the didactic analysis of content proposed by [27] was adapted and selected based on its emphasis on mathematical content from an interdisciplinary and multidimensional perspective.

The curricular didactic analysis of the content of numbers for teaching in early childhood grades from the theoretical and practical structure of the teacher in training, together with the specialized knowledge for the teaching of mathematics, allows for the definition of categories and subcategories of analysis. These will be used to interpret the narratives of the case study teachers, with the aim of triangulating the information made possible by ATLAS ti.9.0 software. The categories and subcategories used to interpret the participants' narratives are presented in Figure 3.

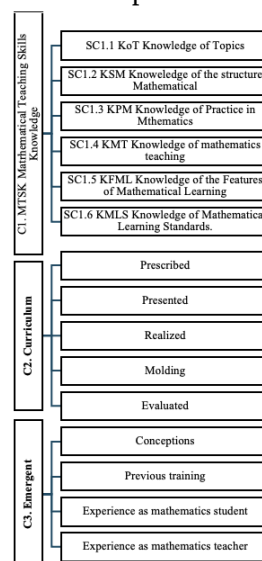


Figure 3. Analysis categories and subcategories
(Developed by the authors)

3.1 Methodological Design

This study was conceived from a complexity perspective [28] and a heuristic phenomenological approach in qualitative research [23]. It focuses on the

description and interpretation of the oral histories [27] of a group of seven teachers who teach natural numbers in different grades in Colombia at the early childhood educational level. The development of this research is a process with the following structure (Figure 4).

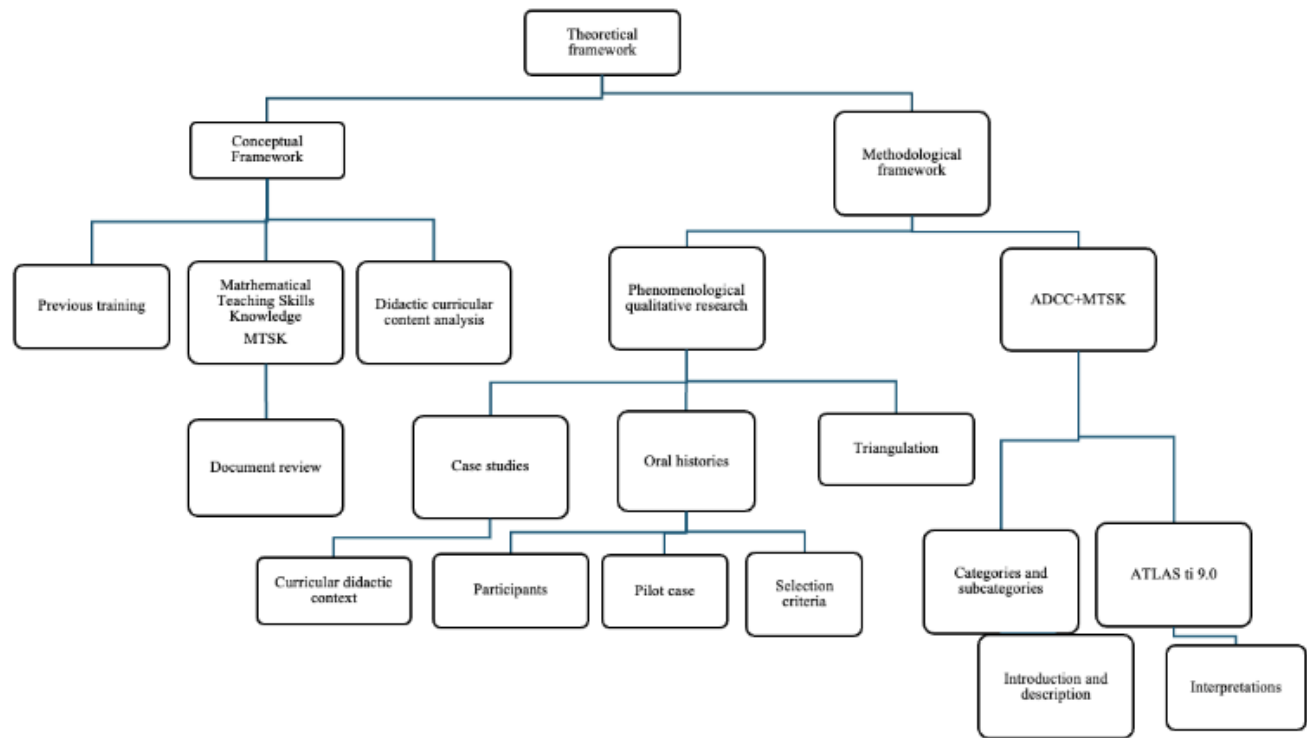


Figure 4. Methodological design structure (Developed by the authors)

3.2. Participants

In this study, participants were selected using the snowball technique [30] based on the criteria of being graduate teachers or in the final semesters of the bachelor’s degree program in early childhood pedagogy. Additionally, they were required to have experience in teaching or have participated in the planning, design, and implementation of didactic strategies or techniques related to numbers.

This initial condition was established based on observations made by the researcher over a three-year period (2018-2021) during which they served as tutors for the subject of Didactics of Mathematics at the Institución Universitaria Antonio José Camacho in Colombia. During this period, the researcher conducted six diagnostic assessments of novice teachers who were either in the initial stages of their pedagogical practices prior to obtaining their bachelor’s degree or were in their fourth semester as interns in child development centers. In emergent cases, these teachers also cared for relatives or acquaintances, as occurred during the COVID-19 pandemic.

In addition to the aforementioned profile of case studies, it is pertinent to consider the modality of blended learning or hybrid learning in which they are trained. The participants’ specific characteristics are listed in Table 1.

Table 1 Participants’ characteristics (developed by the authors)

PSEUDONYM/CASE	GENDER	AGE	PREVIOUS TRAINING	INITIAL TRAINING PROGRAM	GRADE TAUGHT
Any/Piloto Case	Female	35	Early childhood technician	Bachelor's Degree in Early Childhood Pedagogy Institución Universitaria Antonio José Camacho	Neighborhood kindergarten/ 8 years of experien
Lina/Intersection case	Female	24	Teacher Training Colleges Normal superior	Bachelor's Degree in Early Childhood Pedagogy Institución Universitaria Antonio José Camacho	K2. Bilingual private school kindergarten/2 years experience
Brenda	Female	26	Teacher Training Colleges Normal superior	Bachelor's Degree in Early Childhood Pedagogy Universidad Santiago de Cali	K5. Bilingual private school kindergarten/2 years experience
Alila	Female	27	Teacher Training Colleges Normal superior	student in a Bachelor's Degree in Foreign Languages	K5. Bilingual private school kindergarten/2 years experience
Abigail	Female	23	Teacher Training Colleges Normal superior	Does not report	Supports children's homework in Cali's Commune 10
Tati	Female	30	Technical Training	Bachelor's Degree in Early Childhood Pedagogy Institución Universitaria Antonio José Camacho	Kindergarten/ 8 years of experien
Will	Male	39	Early childhood technician	Bachelor's Degree in Early Childhood Pedagogy Institución Universitaria Antonio José Camacho	First year of elementary school in an indigenous reservation/8 years of experience

3.3. Data collection

Data collection began with a review of documents and the construction of the didactic-curricular analysis on the content of numbers for teaching in preschool education.

This analysis is based on the didactic and conceptual structure of the numbers used in the initial

training of early childhood pedagogy graduates. Based on this, an interview was conducted with a pilot case, which allowed us to establish the selection criteria for the participants and adjust the methodological design in three stages.

The participants in the study were selected according to the following criteria: initial training in early childhood pedagogy or related degree programs and pedagogical practice. With regard to the time frame in which the research was conducted, all activities were audio- and video-recorded.

The initial stage comprised a meeting with the teachers who participated in the study by voice-to-voice. During this meeting, the teachers were presented with the main purpose of the research and its relevance to the field of mathematics education and initial mathematics training. A consent form was signed for the treatment of the information, and general information, such as age, gender, previous training, and work experience, was collected.

The second stage is the recognition of the participant through his life story, wherein he elucidates the rationale behind his decision to pursue early childhood pedagogy, offers insights into his academic experience as a mathematics-related discipline, and provides a detailed account of his professional journey as an educator.

The third stage is a discourse on the pedagogy of numeracy in early childhood, wherein participants engage in the socialization of instructional activities designed for young learners. They showcase the manipulative materials utilized in their classrooms and elucidate their pedagogical applications.

4. Results and Discussion

Each teacher was examined as a case study, in accordance with the principles of oral history. Initially, this entailed direct interpretation of the observations made by the researcher. Subsequently, the cases were interpreted in terms of their relationships with the help of categories and subcategories derived from DCAC+MTSK to facilitate cross-referencing of the information.

In general, the oral histories show that the participating teachers, regardless of their place of origin, culture, socioeconomic and political stratum, age, and gender, show an interest in caring for children, considering that they are the center of their family, relatives, and the teaching and learning process in the place where they work. According to the correlation presented between the analysis categories C1. MTSK, C2. Curriculum, C3. Emergent (Figure 5), it is interpreted that participants tend to use their conceptions, beliefs, and experiences as mathematics learners to teach mathematics based on tastes, feelings, and emotions.

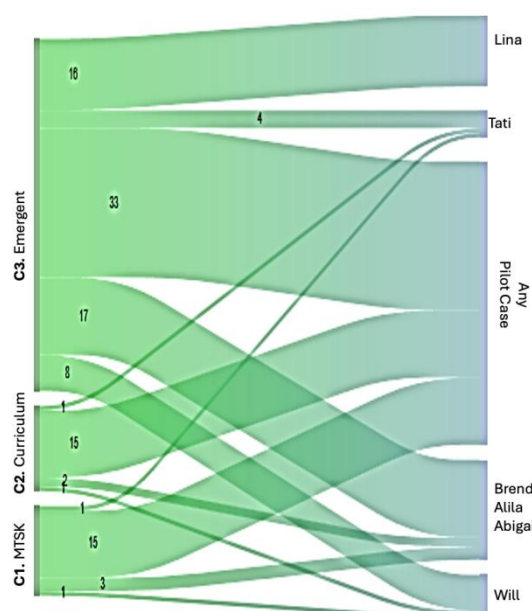


Figure 5. Correlation categories analysis (developed by the authors by ATLAS ti)

Their proximity and affinity with the children incite an interest in accompanying them in their training process, despite their frustration with mathematics. This interest leads them to devise situations or design materials for children to approach mathematics and, in contrast to their own experience, to understand it. However, due to a lack of empathy with the teachers who taught them or the methodologies they used to teach them, many distance themselves from the disciplinary knowledge of mathematics. Some quotes from the cases in relation to these interpretations are as follows.

7:1 Any ... *I like children.*

8:4 Lina (aunt of two nieces at the preschool educational level) ... *because of my attitude and way of relating to them.*

9:5 Brenda (mother of two children ages 5 and 7), Abigail, Alila ... *very close to the children.*

10:4 Tati ... *interest in the child really learning*

11:3 Will ... *the cabildo community manages its own customs*

Other findings of the oral histories in category C3: Emerging and subcategory SC3.1: Conceptions, beliefs, vocation, emotions, present aspects of the reality of the country and the families, such as armed conflicts, displacement, ethnic and socioeconomic differences, violence within the family nucleus, a panorama that leads to psycho-physio-cognitive difficulties that include support from other specialists and accompaniment in the teaching and learning processes. Some situations related to this aspect are as follows.

8:12 Lina (22-year-old woman, teacher, completed a degree in early childhood pedagogy in remote mode) ... *He was a difficult child, he was constantly scolded, but I worked him with love.*

9:14 Alila (27-year-old woman, teacher, graduated

in early childhood pedagogy in remote mode) ... the Patia red zone, the armed groups are making shacks next to the school. I taught preschool through sixth grade, I had to learn, it was a hard year.

11:3 Will (39-year-old man with 8 years of experience working with the community) ...the community of the cabildo decides who educates the children, it cannot be someone other than the community.

Regarding the formation and prior knowledge of the concept of number (SC3.3: Experience as a student), oral histories revealed connections with the manner in which the study participants learned mathematics at school. This was particularly evident in instances of affinity, aversion, or vexation resulting from their pedagogical experiences, including empathy with their instructors or beliefs in their contexts regarding mathematics as a challenging subject. In addition, their own performance in subjects pertaining to numbers was a significant factor.

7:13 Any ... personally I don't like mathematics, its teaching was not dynamic, I got bad grades, ...uncomfortable...

8:6 Lina ...I didn't see any math courses at the university, I was homologated from the teacher training school and I don't remember the mathematics didactics course of the complementary cycle.

10:2 Tati ... the mathematics courses are theoretical and are taught in a traditional way.

11:7 Will ... in my case I was taught with the traditional method as they say colloquially: "numbers enter with blood" and the parents of the community follow the tradition, I learned to add, multiply and by my own means I try to teach them differently ...

In the cross-referencing of sources, the oral histories revealed that, in the context of initial training in a bachelor's degree in early childhood education, the relationship between the subcategories SC1.1: Knowledge of the Topic (KoT), SC1.5: Knowledge for Learning Mathematics (KFLM), SC1.6: Knowledge in Mathematics Learning Standards and Guidelines (KMLS), SC2. 1: Prescribed Curriculum, SC2.2: Presented Curriculum, SC2.4: Evaluated Curriculum, and SC3.3: Experience as a Teacher facing Number ADCC, shows that the conceptualization of curriculum as a theoretical, conceptual, and practical construct should be flexible and viewed from complexity as a network of networks. Early childhood educators are expected to possess mathematical knowledge that allows them to act as active companions in the training process, creating learning experiences based on children's interests and needs. This approach should foster multidimensional, interdisciplinary, and intercultural development, respecting diversity, and promoting social and environmental responsibility from a critical, scientific, and complex perspective.

It is also noted that, from the perspective of the experience of the case studies, the number is

conceived, learned, and taught as a content that becomes relevant in the pre-operational stage (5 to 6 years old) of early education, when the child must take the step to primary school (kindergarten) and must know, according to their cognitive development and the standard of the educational level, to recognize and represent numbers by means of the Indo-Arabic symbol, to count using the number as a cardinal reference object, set and symbol, to recognize, sign, and write the series of numbers, first from 1 to 3, then from 1 to 5, from 1 to 10, until they reach a number that allows them to make the decomposition and composition of the number, to assimilate elements of the grouping to make additions of sets, and to show the differences between them (additions and subtractions). Some quotations that give rise to this interpretation are

12:18... we are supposed to start from the children's interests, one day they started talking about dinosaurs and we made them some eggs with one half broken into balls and the other half with a number written on them.

12:1...the objective is that they count balls, form groups and find their complement which is the symbol that represents the quantity.

12:22 ...observing them during their play time in each of the stations we realized that they like to play the customer and the shopkeeper and we simulated a store, they made bills and labeled them, adding and subtracting with the help of the Cusieren strips.

12:24 ...within the curriculum there are indicators and they say what each child should do, from the ages they are taught and with this activity they were fulfilled.

12:27 ...together with the head teacher they work with the strips, colors and sizes for grouping, counting in their mother tongue and English. Each child has a bag with 10 pieces, identifies the number by placing the number of pieces on a board. The tools are standardized so that the children can perform the activities without the difficulty of different colors.

As evidenced in the above quotations, the elements that were considered and expected to be evidenced in the categories and subcategories of analysis of the participants' initial training profile include the following:

Various systems of representation, such as graphs and tables, as well as phenomenological aspects, such as subsidization and estimation. These elements are fundamental for enhancing the definition of numbers (SC1.1: KoT). With regard to the mathematical structure of numbers (SC1.2: KSM), its interconnection with other disciplines, its relationship with preceding and subsequent concepts within mathematics, and its utility and applicability across disciplines were examined.

From the knowledge of mathematics teaching (SC1.3: KMT), the theories of specific didactics, the support of emerging technologies, and classroom proposals according to their realities within the

framework of institutional guidelines were replaced by the theories of general didactics and socio-cognitive contributions. Although they are the foundations for understanding the teaching and learning processes, they do not address elements specific to the objects of study of a discipline.

Additionally, it was anticipated that the curriculum would be developed and implemented (SC2.3 and SC2.4) in accordance with international, national, and institutional guidelines, which would facilitate the child's contextualization of the numerical concept. However, the educational practice in question demonstrates an exploration of the materials, but not of the context and reality. The child follows direct instructions from the head teacher, who provides support to the assistant through the guide or card if the two are in different spaces but at synchronous times.

The activities prioritize the symbolic representation of numbers for the sole purpose of counting and seriation, with the ultimate goal of enabling students to safely progress to the next educational level. The curriculum serves as a pathway for students to demonstrate their cognitive growth. However, participating teachers identified additional challenges that necessitate reflection and self-training.

8:10 ...I have to study to be able to teach children when they are not in the age range or educational level.

8:13 ...in the COVID-19 pandemic, with the older children the homework was sent, but with the younger ones it was difficult, you need the support of the parents or guardians to help them do the exercises and they could observe, the telephone follow-up, the experience.

9:4 ...Yes, my son does number recognition, but sometimes he flips them over, the teacher says: he doesn't know the numbers.

12:8 ...special case, a K2 girl who was even hospitalized for the language issue, a very slow process, she did not speak, she only said Mm, Mm starting therapy with psychology and speech therapy, working first with colors, although she does not pronounce them well, when she wanted to say red, she said rare...

The interpretation of the oral histories, the primary source of the research, concludes with an intersection case. Having completed the initial training in the degree program in early childhood pedagogy and previous training as a teacher in pedagogy in a specialized high school, the case presents a pedagogical practice characterized by an exclusive reliance on MTSK conceptions and C3 category analysis in teaching number.

The study involved an interpretation of the documentary information and the experiences and conceptions of the participating teachers in light of the curricular didactics of mathematics. This analysis concluded that the teachers identified generalities of

the general didactics but not of the specific didactics, that is, of the didactics of mathematics. Mathematical content is the focal point of this study. The conceptual didactic structure of the concept of number, as perceived by the participating teachers, deviates significantly from the one presupposed by the mathematical didactic curriculum presented in the mathematics didactics course of the degree program in early childhood pedagogy. This is due to the fact that their narratives are limited to the relationships, considerations, and interests of the children demonstrated a lack of understanding of fundamental mathematical principles, such as one-to-one correspondence, stable order, abstraction, relevance of order, cardinalization [31], and putting tastes, feelings, and emotions in the activities to overcome the frustration of a traditional mathematics teaching-learning process. This was observed outside the framework of the discipline of mathematics.

The analyses of the case studies show other elements of training that emerge for each situation, in which the participating teachers do not know how to articulate them with mathematical disciplinary and professional knowledge, taking on each challenge of pedagogical practice from their experiences, conceptions, beliefs, and experiences as students.

5. Conclusions

The analysis of teachers' narratives, focusing on their pedagogical practice, revealed the presence of specific mathematical knowledge that was presented in varying degrees in relation to the balance and interrelation that must be maintained. These included aspects of number definition through symbolic representation, which were not applicable to the teaching of numbers at all preschool grade levels. The knowledge base underlying mathematical practice and learning standards encompasses the advancement of mathematical, numerical, special, and data processing capabilities. This is achieved through multidimensional work that aligns with the prescribed global mathematical curriculum and the curriculum presented by the educational institution in terms of attaining a new level of academic achievement.

From a qualitative, interpretative perspective, the research focused on the study of the initial mathematical training of early childhood teachers, allowing us to explore the formative experiences of teachers and how they affect their attitudes, as well as the meaning of mathematical concepts, by incorporating emotional elements at a local level. In light of the above, it is recommended that the attitudes and emotions that emerge in educational practices be included in reflection sessions as an aspect of teaching mathematics at an early age. These should be regarded as coping skills, as a means of changing perspectives, and strengthening confidence in mathematical

knowledge.

It is recommended that undergraduate students or professionals who work with early childhood in mathematical knowledge incorporate experiences in real contexts where didactic-mathematical knowledge is evidenced as professional knowledge centered on being, developed from the theoretical-practical, validating in the implementation of activities or use of physical or technological resources, the mathematical concept from its didactic-conceptual structure, regardless of the situation that emerges, for which training programs are proposed that promote research, leadership, entrepreneurship, innovation, recognition of self and others, interdisciplinarity, diversity, and interculturality.

This research makes a significant contribution to the field of Early Childhood Education by providing insight into the specific challenges faced by preschool teachers in the field of mathematics. It offers valuable guidance for the adaptation of initial training curricula in mathematics, particularly regarding the didactics of mathematics and the role of emotions in the teaching of mathematics in early childhood.

In the field of mathematics education, this study suggests a reflection on didactic strategies and techniques for teaching numbers that emphasize their significance in a specific context. This is achieved through a curricular didactic analysis of the content and a model of analysis of the teacher's specialized knowledge, which is centered on conceptions.

In the field of initial training for mathematics teachers, models of analysis of mathematical knowledge as a training tool have the potential to serve as an integrating axis for mathematical content in a variety of contexts and realities. This is because they facilitate the validation of disciplinary knowledge in an interdisciplinary manner, allowing multidimensional and inclusive approaches.

Declarations

Author Contributions

Conceptualization, L.A.P.C.; methodology, L.A.P.C.; software, L.A.P.C.; validation, S.R.A.; formal analysis, L.A.P.C. and S.R.A.; investigation, L.A.P.C.; resources, L.A.P.C.; data curation, L.A.P.C. and S.R.A.; writing—original draft preparation, all authors contributed equally; writing—review and editing, S.R.A.; visualization, L.A.P.C. and S.R.A.; supervision, S.L.C.V.; project administration, L.A.P.C. and S.L.C.V. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

Restrictions apply to the availability of these data. Data were obtained from a third party and are available at the Consents & Interviews Link with their

permission.

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

References

- [1] CONGRESS OF THE REPUBLIC OF COLOMBIA. Ley 115 de 1994 whereby the general education law is enacted, 1994
- [2] BUSTAMANTE S. *Logical mathematical development, Mathematical learning for children*. Quito- Ecuador, 2015.
- [3] GÓMEZ-CHACÓN I. M., & MARBÁN J. M. Affect and teacher' professional knowledge in mathematics. In BADILLO E., CLIMENT N., FERNÁNDEZ C., & GONZÁLEZ M. T. (Eds.) *Research on the mathematics teacher: training, classroom practice, knowledge and professional competence*, (397-416). Salamanca: Ediciones Universidad Salamanca, 2019.
- [4] JIMÉNEZ-ESPINOSA A. & SÁNCHEZ-BAREÑO D. M. Pedagogical practice from a-didactic situations in mathematics. *Journal of Research, Development and Innovation*, 2019, 9(2): 333-346.
- [5] AGUILAR Á., CARREÑO E., CARRILLO YÁÑEZ J., CLIMENT RODRÍGUEZ N., CONTRERAS GONZÁLEZ L.C., ESCUDERO D.I., FLORES MEDRANO E., FLORES P., MONTES M., & ROJAS N. The specialized knowledge of the mathematics teacher: MTSK. *Proceedings of the VII Congreso Iberoamericano de Educación Matemática* (September 16-20, 2013, Montevideo), pp. 5063-5069. <https://rabida.uhu.es/dspace/handle/10272/8268>.
- [6] BOLÍVAR A. Teachers' life histories: voices and contexts. *Mexican Journal of Educational Research*, 2014, 19(62): 711-734.
- [7] FERNÁNDEZ PLAZA J.A. Content Analysis. In ROMERO L.R., & VERDEJO A. M. (Eds.) *Elements of mathematics didactics for the secondary school teacher* (pp. 103-118). Pirámide, 2016.
- [8] FLORES-MEDRANO E., ESCUDERO-ÁVILA D.I., & CARRILLO J. The use of MTSK in the initial training of primary mathematics teachers. *Revista de análisis matemático-didáctico para profesores*, 2014, 1: 16-26.

- [9] INSTITUCIÓN UNIVERSITARIA ANTONIO JOSÉ CAMACHO [UNIAJC]. Curriculum for the bachelor's degree program in early childhood education, 2019.
- [10] MINISTERIO DE EDUCACIÓN NACIONAL [MEN]. *Series of curricular guidelines for mathematics*. Bogotá, 1998.
- [11] MINISTERIO DE EDUCACIÓN NACIONAL [MEN]. *Basic competency standards, language, mathematics, science and citizenship*. Bogotá, 2006.
- [12] MINISTERIO DE EDUCACIÓN NACIONAL [MEN]. *Basic Learning Rights in Mathematics Vol.2*. 2015. https://wccopre.s3.amazonaws.com/Derechos_Basicos_de_Aprendizaje_Matematicas_1.pdf
- [13] POTOSÍ CRUZ, L. A. *Didactic analysis of the mathematics teacher training model based on project work: the case of the function concept*. Biblioteca Digital - Universidad del Valle, 2019. <https://bibliotecadigital.univalle.edu.co/handle/10893/12772>.
- [14] MUÑOZ CATALÁN M.C., CONTRERAS L.C., CARRILLO J., ROJAS N., MONTES M. Á. & CLIMENT N. Mathematics teacher specialized knowledge (MTSK): an analytical model for the study of mathematics teacher knowledge. *The Gazette of the Spanish Royal Mathematical Society*, 2015, 18(3): 1801-1817.
- [15] CARRILLO J., CLIMENT N., MONTES M., CONTRERAS L., FLORES E., ESCUDERO D., VASCO D., ROJAS N., FLORES P., AGUILAR A., RIBEIRO M. & MUÑOZ M. The mathematics teacher's specialised knowledge (MTSK) model. *Research in the Mathematics Education*, 2018, 20(3): 236-253. <https://doi.org/10.1080/14794802.2018.1479981>.
- [16] POTOSÍ CRUZ L.A. *Characterization of the initial training in mathematics of teachers in early childhood pedagogy from their narratives around the teaching of number in preschool*. Unpublished doctoral thesis. Universidad Santiago de Cali. Cali-Colombia, 2024.
- [17] RICO, L. Mathematics curriculum organizers. In RICO L. (Ed.) *La Educación Matemática en la Enseñanza Secundaria* (pp. 39-59). Barcelona: 1997.
- [18] MINISTRY OF NATIONAL EDUCATION. Resolución 6966 de 2010, whereby articles 3 and 6 of Resolution 5443 of 2010, which define the specific quality characteristics of professional training programs in education, are modified. 2010.
- [19] CARRILLO J., CLIMENT N., CONTRERAS L.C., & MUÑOZ-CATALÁN M.C. Determining specialised knowledge for mathematics teaching. *Proceedings of the CERME 8*, 2013 (2985-2994)
- [20] CONTRERAS GONZÁLEZ L.C. The concept of number in early childhood education. *Magazine SUMA*, 1989, 3(19): 29-33.
- [21] PIAGET J., & SZEMISNKA A. *Genesis of number in the child*. Guadalupe, Buenos Aires, 1975.
- [22] CHAMORRO M. *Mathematics didactics*. Pearson Prentice Hall, 2005.
- [23] HERNÁNDEZ SAMPIERI R., FERNÁNDEZ C., & BAPTISTA L. *Research methodology*. 6ta. Edición McGraw-Hill, 2014.
- [24] RODRÍGUEZ GÓMEZ G., GIL J. & GARCÍA E. *Qualitative Research Methodology*. 2nd Edition. Ediciones Aljibe, 1999.
- [25] COHEN L., & MANION L. *Educational Research Methods*. Editorial La Muralla, S.A., 1989
- [26] BERICAT E. *Investigation of quantitative and*

qualitative methods in social research. Meaning and measurement. Barcelona: Ariel, 1998.

- [27] FERNADEZ PLAZA J. A. Content analysis. In MORENO R., and VERDEJO A. M. (Eds.). *Elementos de la didáctica de la matemática para el profesor de secundaria* (pp. 103-118) Piramide, 2016.
- [28] BUENDÍA L., GONZÁLEZ D., GUTIÉRREZ J. & PEGALAJAR, M. *Educational Research Analysis Models*. ALFAR, 1999.
- [29] GUEDES CURY F. Oral History and narrative analysis of narratives in the mathematics education research in Brazil. *History of Education: University Journal*, 2017, 36: 169-186.
- [30] ALEJO M., & OSORIO B. The informant as a key person in qualitative research. *Pedagogy Gazette*, 2016, 35: 74-85.
- [31] RUIZ HIDALGO J. F. Teaching and learning of mathematics in early childhood education, by Encarnación Castro and Enrique Castro. *Edma 0-6: Mathematics Education in Childhood*, 2021, 5(1): 73-75. <https://doi.org/10.24197/edmain.1.2016.73-75>.

参考文献:

- [1] 哥伦比亚共和国国会。1994 年第 115 号法律，颁布了《普通教育法》，1994。
- [2] BUSTAMANTE S. 逻辑数学发展，儿童数学学习。基多-厄瓜多尔，2015。
- [3] GÓMEZ-CHACÓN I. M. 和 MARBÁN J. M. 数学中的影响和教师的专业知识。在 BADILLO E., CLIMENT N., FERNÁNDEZ C. 和 GONZÁLEZ M. T. (编辑) 数学教师研究：培训、课堂实践、知识和专业能力，(397-416)。萨拉曼卡：萨拉曼卡大学，2019。
- [4] JIMÉNEZ-ESPINOSA A. 和 SÁNCHEZ-BAREÑO D. M. 数学教学情境中的教学实践。研究、发展与创新杂志，2019, 9(2) : 333-346。
- [5] AGUILAR Á., CARREÑO E., CARRILLO YÁÑEZ J., CLIMENT RODRÍGUEZ N., CONTRERAS GONZÁLEZ L.C., ESCUDERO D.I., FLORES MEDRANO E., FLORES P., MONTES M., 和 ROJAS N. 数学教师的专业知识：MTSK。第七届伊比利亚美洲教育大会会议记录（2013 年 9 月 16 日至 20 日，蒙得维的亚），第 5063-5069 页。 <https://rabida.uhu.es/dspace/handle/10272/8268>。
- [6] BOLÍVAR A. 教师的生活史：声音和背景。墨西哥教育研究杂志，2014, 19(62) : 711-734。
- [7] FERNÁNDEZ PLAZA J.A. 内容分析。载于 ROMERO L.R. 和 VERDEJO A.M. (编) 《中学教师数学教学原理》（第 103-118 页）。金字塔，2016。

- [8] FLORES-MEDRANO E., ESCUDERO-ÁVILA D.I., 和 CARRILLO J. MTSK在小学数学教师初始培训中的运用教授数学教学分析回顾, 2014, 1: 16-26.
- [9] 安东尼奥·何塞·卡马乔大学研究所 [UNIAJC]. 2019年幼儿教育学士学位课程课程表。
- [10] 国家教育部。数学课程指南系列。波哥大, 1998。
- [11] 国家教育部。基本能力标准、语言、数学、科学和公民身份。波哥大, 2006。
- [12] 国家教育部。数学基本学习权利第 2 卷。2015。https://wccopre.s3.amazonaws.com/Derechos_Basicos_de_Aprendizaje_Matematicas_1.pdf
- [13] POTOSÍ CRUZ, L. A. 基于项目工作的数学教师培训模式的教学分析：函数概念的案例。数字图书馆 - 瓦莱大学, 2019。https://bibliotecadigital.univalle.edu.co/handle/10893/12772
- [14] MUÑOZ CATALÁN M.C., CONTRERAS L.C., CARRILLO J., ROJAS N., MONTES M. Á. 和 CLIMENT N. 数学教师专业知识 (MTSK): 数学教师知识研究的分析模型。西班牙皇家数学学会公报, 2015, 18(3): 1801-1817。
- [15] CARRILLO J., CLIMENT N., MONTES M., CONTRERAS L., FLORES E., ESCUDERO D., VASCO D., ROJAS N., FLORES P., AGUILAR A., RIBEIRO M. 和 MUÑOZ M. 数学教师专业知识 (MTSK) 模型。数学教育研究, 2018, 20(3): 236-253。https://doi.org/10.1080/14794802.2018.1479981。
- [16] POTOSÍ CRUZ L.A. 根据学前教育中数字教学的叙述, 描述了幼儿教育学教师的初始数学培训特征。未发表的博士论文。卡利圣地亚哥大学。卡利-哥伦比亚, 2024。
- [17] RICO, L. 数学课程组织者。载于 RICO L. (主编) 中等教育中的数学教育 (第 39-59 页)。巴塞罗那: 1997。
- [18] 国家教育部。2010 年第 6966 号决议, 对 2010 年第 5443 号决议第 3 和第 6 条进行了修改, 这些条款规定了教育专业培训计划的具体质量特征。2010。
- [19] CARRILLO J., CLIMENT N., CONTRERAS L.C. 和 MUÑOZ-CATALÁN M.C. 确定数学教学的专业知识。CERME 会议论文集 8, 2013 (2985-2994)
- [20] CONTRERAS GONZÁLEZ L.C. 幼儿教育中的数字概念。SUMA 杂志, 1989, 3 (19): 29-33。
- [21] PIAGET J., 和 SZEMISNKA A. 孩子中数字的起源。瓜达卢佩, 布宜诺斯艾利斯, 1975。
- [22] CHAMORRO M. 数学教学法。皮尔逊·普伦蒂斯·霍尔, 2005。
- [23] HERNAÁNDEZ SAMPIERI R., FERNÁNDEZ C. 和 BAPTISTA L. 研究方法。第六。麦格劳-希尔版, 2014。
- [24] RODRÍGUEZ GÓMEZ G., GIL J. 和 GARCÍA E. 定性研究方法。第二版。阿尔吉贝版, 1999。
- [25] COHEN L., 和 MANION L. 教育研究方法。社论 La Muralla, S.A., 1989。
- [26] BERICAT E. 社会研究中定量和定性方法的调查。意义和测量。巴塞罗那: 阿里尔, 1998。
- [27] FERNANDEZ PLAZA J.A. 内容分析。见 MORENO R. 和 VERDEJO A. M. (编)。中学教师数学教学要素 (第 103-118 页) 金字塔, 2016。
- [28] BUENDÍA L., GONZÁLEZ D., GUTIÉRREZ J. 和 PEGALAJAR, M. 教育研究分析模型。阿尔法, 1999。
- [29] GUEDES CURY F. 巴西数学教育研究中的口述历史和叙事分析。教育史: 大学学报, 2017, 36: 169-186。
- [30] ALEJO M., 和 OSORIO B. 线人作为定性研究的关键人物。教育学公报, 2016, 35: 74-85。
- [31] RUIZ HIDALGO J. F. 《幼儿教育中数学的教学与学习》, Encarnación Castro 和 Enrique Castro 着。Edma 0-6: 童年数学教育, 2021, 5(1): 73-75。https://doi.org/10.24197/edmain.1.2016.73-75。

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