

# Historical analysis of mathematic in Cuba primary education in 19th and 20th centuries<sup>1</sup>

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**Abstract:** The article presents a study of mathematics as a science and its teaching in primary education in the nineteenth and twentieth centuries. It characterizes the primary level and the evolution of primary education in these centuries, highlighting the main personalities of the time and their contributions. The objective set by the authors is to reveal the regularities of the teaching of mathematics in Cuba from 1850 to 1959. The research method used is documentary analysis. The study takes into account the psychological and pedagogical characteristics of students at this level of education, where the development of some of the higher psychological functions is only formed at school. It also takes into account the fundamental elements of mathematics in this century: the separation from reality and the increase of logical rigor in obtaining results. The impact that the development of mathematics in the 19th and 20th centuries has had on current primary education is presented

**Keywords:** mathematics; primary education; mathematics teaching

## 1 Introduction

Mathematics is one of the subjects that is present in all educational systems worldwide. In each one of them, there is a curricular design where the contents to be studied and the aspirations with that content are placed. Hence, the learning of Mathematics takes place from the earliest ages and has the purpose of developing in the child the operations and logical processes of thought (Torkildsen et al., 2023).

Each educational subsystem integrates new content based on the preceding ones, which means that mathematics teaching has a marked cumulative character. The guidelines propose an organization of the content and its forms of presentation in classes. Hence, the learning of mathematics in primary education is essential for the rest of the grades.

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One of the principles that governs teaching is its scientific nature (González, 2021a). Mathematics is a science that has had a long history since its development as a human being until the present time. Since the human being needed to count and distribute, he has been doing mathematics, which has become more and more complex. And since that initial period, mathematics has been part of the contents to be learned. However, in the present time, deciding these contents is becoming a more and more complex task by the very development of mathematics at present. (Thompson; Owen; Hastings, 2024).

One solution to this problem would be to constantly update the contents to be taught. This would lead to the introduction of new content every certain period of time; however, what to do if you need all the content that is already in the curriculum? This would lead to increasingly shorter learning times for each content and, as new ones are introduced, the time would be further reduced. At the same time, how to do it in primary education if Mathematics is already known as a difficult and complicated subject (Bueno; Naveira; González; González, 2020; Hernández; González; Naveira, 2020).

In the case of Mathematics, the answer involves the analysis of the development of this science at present and what of this development to reflect as school content. Primary education is one of the most important, since it lays the foundations for subsequent studies of this subject and others that are related.

Much has been written about the teaching of mathematics in primary education in Cuba in the period from 1959 onwards and there is abundant literature on the subject (Cabrera; Pérez, 2011; Ariza; Sánchez; Pérez, 2015; Pedroso, 2021). However, no references are obtained in this literature about the teaching of Mathematics from 1850 to 1959. The didactic references found are from Cuban pedagogues such as Luz y Caballero (1800-1862), Rafael María de Mendive (1821-1886) and others who were not Mathematics teachers. Only one article is found referring to the history of mathematics teaching in Cuba (Pedroso, 2009), but when dealing with the period, it only deals with pedagogical authors. The subjects referring to History of Mathematics, History of Education in Cuba and others in the training of Mathematics teachers do not have references about their teaching in the period from 1850 to 1959. Therefore, the objective of this article is to unveil the regularities of Mathematics teaching in Cuba from 1850 to 1959.

Documentary analysis has become one of the qualitative methods (Hernández; Fernández; Baptista, 2014) currently used when one wants to detect research in a little explored environment. A large number of investigations use documentary analysis as a fundamental method (Mosen; Williams; Schubert, 2024; Zangerl et al., 2024; Romeu De Mazzi et al., 2023). Table 1 shows the phases used for each:

**Table 1** – Phases recognized by the authors.

Authors	Information Search	Text Retrieval	Information Organization	Critical Analysis	Gap Detection	Proposed Solution
Zangerl <i>et. al.</i> , 2024	X	X	X	X	X	
Mosen; Williams; Schubert, 2024	X	X		X		
Romeu De Mazzi <i>et. al.</i> , 2023	X	X	X			

Source: Authors elaboration (2024)

The method used in this research is the documentary analysis, although the last stage shown in the table has been added, which aims to obtain a solution to the gap detected on the teaching of Mathematics in the Cuban elementary school of the XIX and XX centuries. Each of the stages will be described in the article in the corresponding sections.

First stage: A search was carried out in the Web of Science through the search engine [www.sciencedirect.com](http://www.sciencedirect.com) using the terms Mathematics Education Primary as follows: (Mathematics) and (Education) and (Primary) and (Century) and (19th) and (20th) in the title of the article. The search was performed using the keywords in Spanish with the same structure, but with the words in Spanish. The search links and the number of documents obtained are shown below: In this first search 1536 documents were obtained<sup>2</sup>. In this direction 38<sup>3</sup>. were obtained. Another database used for the search was Scielo ([scielo.org](http://scielo.org)) with the same elements, obtaining 159 documents<sup>4</sup>.

Second stage: The total number of documents obtained from the searches was 1733 documents. All of them could be downloaded and were analyzed as references for the construction of mathematics education in primary education; however, only one book was found on mathematics education in Cuba during the period from the mid-19th to the mid-20th century.

Third stage: All the documents were inserted in a digital library created with Zotero and were organized for their use as theoretical references.

<sup>2</sup> <https://www.sciencedirect.com/search?q=mathematic%2C%20teaching%2C%20education%2C%20primary%2C%20century%2C%2019th%2C%2020th>

<sup>3</sup> <https://www.sciencedirect.com/search?q=matem%C3%A1tica%2C%20ense%C3%B1anza%2C%20educaci%C3%B3n%2C%20primaria%2C%20siglo%2C%2019%2C%2020>

<sup>4</sup> <https://encurtador.com.br/1XJRb>

The article is developed in 3 more chapters after the first one. The first section proposes documentary analysis as the proposed methodology and the way it was conducted. A second one describes primary education in Cuba in the proposed period. The third one is dedicated to the analysis of Mathematics teaching in the selected period and its marked utilitarian character. The last section proposes the development of Mathematics during the 19th and 20th centuries to support the training of Mathematics teachers and how it has impacted on primary education in Cuba.

## **2 Primary education in Cuba between 1850 and 1950.**

Education in the first levels of education is of utmost importance, as it develops the child's first experiences in relation to school. It is the learning space (González, 2021) par excellence where the child will learn under the guidance of an adult who is prepared to lead him/her. In addition, it is in the space where all the conditions are created for an environment conducive to learning.

In this regard, Bozhovich states:

In order to understand exactly what influence the environment exerts on the child and, consequently, how it determines the course of his development, it is necessary to understand the character of the child's experiences, the character of his affective relationship with the environment (1981, p. 123).

Hence, the importance of affective processes, especially emotional ones, in the learning process is recognized. In the case of the child, these contradictory situations should stimulate learning with increasingly complex situations. As the author Bozhovich states “[...] it is possible to affirm that pupils of small school age are interested in all kinds of serious teaching work, but that they prefer those which, being more difficult and complex, demand greater mental tension [...]” (p. 205). Each situation solved by oneself or with the help of others enables the emergence of subjective senses favorable to the solution of different problems in which new areas of meaning are produced and these senses are integrated into subjective configurations favorable to learning. However, given the limitation of knowledge, in the first two years students direct their attention to isolated facts that later in the third and fourth grades are integrated to explain causal relationships.

The teacher's stimulation of these processes from the emotional support he provides integrates these processes to the subjective configuration of learning. At the end of primary education, from the subjective configurations of learning formed in each student, preferences for certain subjects, or groups of them, begin to appear, which are corroborated with the expressions “I feel better with letters”, “I like mathematics”, “I am interested in natural sci-

ences”. In this way, some of the essential aspects that can determine their future projection and even their profession in higher grades are delineated.

In the same way, it is important to pay attention to the processes of behavior regulation in close relationship with the family, since in the first years they show great impulsivity. In cases that require movement due to the need for accumulation, the teacher can propose brief exercises to relieve tension. It may also be a valid procedure to ask particularly restless children to go to the blackboard to write notes. These procedures are especially important in mathematics classes when the child is sitting for a long time in front of a computer.

The evolution of primary education in Cuba throughout the 19th and 20th centuries was marked by significant changes in its structure, access and methodology, influenced by political and social contexts. Primary education in Cuba began to take shape at the end of the 18th century with the creation of the “Sociedad Económica de Amigos del País” (Economic Society of Friends of the Country) in 1793, which promoted popular education. In 1816, a public instruction plan was established that laid the foundations for education in the country.

The 19th century, considered the time of the beginning and early development of primary schools in Cuba. The implementation of the Public Instruction Plan by the Spanish government in 1842, which sought to improve primary education, although there was a very small number of schools, it is in 1843 with the school reform where Municipal Schools were created in several of the country's localities (Carrillo, 1946). The first of these institutions was established in Guanabacoa in 1857, and was followed by two more in Havana in 1890, one for the training of teachers and the other for female teachers. These institutions were designed to improve the quality of primary education and ensure that teachers received adequate preparation. Due to the political situation in Cuba and the independence movements, the Spanish authorities decided that teacher training should not remain under Cuban control, entrusting this task to the Piarist Fathers.

During the Ten Years' War (1868-1878), an emancipationist pedagogy emerged that promoted the creation of schools in the regions controlled by the Mambises. These schools served a diverse population, promoting inclusive education (Avalo, 2016). This period was crucial for the development of an education that responded to the needs of a population struggling for its emancipation and aligned with its ideals of freedom and social justice.

During this stage, a remarkable development process was experienced, driven by various figures who promoted teaching and teacher training in a colonial context (Gil; Expósito; Bartutis, 2003; Buenavilla et al., 2014). Presbyter José Agustín Caballero (1762-1835), was a prominent educator and member of the “Economic Society of Friends of the Country”, promoted the creation of elementary schools and the improvement of public edu-

cation. His work included the elaboration of a project of ordinances for public schools, which was approved in 1794, laying the foundations for the educational organization in Cuba.

Improving teaching conditions and promoting a more accessible education for all Cubans was the focus of attention of Francisco de Isla (1740-1816), as a notable member of the Economic Society, he also contributed to the development of educational reforms. The actions carried out by Alejandro Ramirez (1775-1849), as intendant and president of the Economic Society between 1815 and 1823, stand out. He promoted public instruction in Cuba, managed the creation of university chairs and elementary schools, as well as a project to establish a "Lancasterian Normal School", which sought to improve the training of teachers. It is worth highlighting the active participation of Fray Felix Gonzalez in the promotion of primary education, his collaboration with the Economic Society to establish schools and improve educational conditions, especially for the most disadvantaged sectors.

The educator and intellectual Manuel Sanguily (1830-1910) was a defender of the Cuban educational system and worked to promote educational reforms during the period of the struggle for independence. His work included efforts to establish a national education that responded to the needs of the Cuban people. On the other hand, Rafael Morales (1861-1938) known as Moralito, an outstanding pedagogue, promoted innovative educational methods during this period, including the use of primers and didactic materials that facilitated learning in primary schools.

José Martí (1853-1895) played a crucial role in Cuban education, even though his activity was mainly concentrated in the second half of the 19th century. He promoted a comprehensive education that not only sought academic training, but also fostered critical thinking and love for the homeland. His educational approach emphasized the importance of forming citizens committed to their country and with solid ethical values, which has left a profound influence on subsequent generations (Socarrás; Socarrás, 2010).

A fundamental figure in primary education in Cuba during the 19th century was José de la Luz y Caballero; his contributions were significant and laid the foundations for the development of the Cuban educational system (Cruz, 2005). In 1833, José de la Luz y Caballero presented a project to the Junta de Fomento for the creation of a Cuban Institute, where he proposed the establishment of a Normal School. This idea was pioneering, since it was proposed six years before similar institutions arose in the United States and Spain.

His goal was to train teachers who could offer a competent public education aligned with Cuba's patriotic needs. He advocated for an education that not only instructed in academic knowledge, but also formed citizens committed to their homeland. In his writings, he emphasized that education should be a collective effort, involving parents, teachers and the community. He implemented teaching methods that encouraged students to think for themselves. He considered the starting point of knowledge to be experience and observation,



and defended the experimental method as the only truly analytical method. This represented a significant departure from the scholastic methods prevalent in his time.

In 1848, he founded the “Colegio del Salvador”, where he implemented modern teaching methods and offered a variety of subjects, including languages and philosophy. This school became an educational model that promoted research and active learning (Carrillo, 1946). Luz y Caballero was an advocate of critical thinking and humanistic education. His legacy lives on in Cuban education today, where his ideas on the integral formation of the individual are still relevant. His approach to pedagogy as a science was innovative for his time.

During this period, free schools of mercantile arithmetic and shorthand were established, and the school of political economy was reopened, with Antonio Bachiller y Morales as professor. The Public Instruction Plan instituted the Inspection and Study in Havana, creating provincial and municipal commissions for primary education. This plan covered subjects such as Christian religion, morals, writing, arithmetic, Spanish grammar, linear drawing, general notions of physics and chemistry, natural history, geography of Cuba, geography of Spain and history of Spain (Gil; Expósito; Bartutis, 2003).

Primary education in Cuba during the 20th century underwent significant transformations, influenced by political, social and economic changes. This period spanned from the U.S. intervention to the Cuban Revolution, marking a path towards modernization and educational inclusion. After the U.S. occupation (1899-1902), reforms were implemented that modernized the educational system. A new administrative structure was established and more advanced pedagogical methods were promoted. New educational institutions were created, including the Secretariat of Public Instruction. However, the educational system faced serious deficiencies, with a high rate of illiteracy and scarcity of resources.

In 1909, the First School Law established primary education as compulsory and free, laying the foundations for a more accessible educational system. It recognized the particularities of rural and urban schools, establishing a legal framework for primary education. From 1913, urban and rural schools were differentiated (Avalo, 2016). In the period from 1902 to 1917, numerous schools (Cartaya; Juanes, 1996) or house-schools were created, propitiated by E. J. Varona vice president of the republic of Cuba achieved from including in the state budget a credit for these purposes, in 1921 the works were paralyzed due to the economic crisis and the embezzlement of funds destined to education.

New subjects were introduced, including civics, handicrafts and agriculture, reflecting a more comprehensive approach to student education. Music and art education also began to play a prominent role in the school curriculum (Public, 1914a). Normal Schools for teacher training were expanded, with a focus on modern and scientific pedagogical methods (Martínez, 2017). This was crucial to raise the quality of primary education. Significant

efforts were made to bring education to rural areas, where illiteracy was high. Rural schools and literacy programs were established to serve this population.

It is significant to point out that in this stage personalities such as the outstanding pedagogue Alfredo Aguayo (promoted the New School, emphasizing an active approach to learning, defended the improvement of teacher training and published works on pedagogy that influenced his time), José Manuel Lazo (1919-1961) was fundamental in the training of teachers and in the implementation of modern pedagogical methods, contributing to the development of the Cuban educational system, Gaspar Agüero Barreras (1873-1951), pianist and music pedagogue who founded the Chair of Music at the Normal School for teachers in Havana, promoting music as an integral part of primary education and Hortensia Mirabal Vega, educator and innovator who contributed to the training of teachers and worked in various rural schools, known for her progressive pedagogical approach and commitment to social causes.

Félix Varela y Morales was a key figure in primary education in Cuba during the 19th and early 20th centuries (Gil; Expósito; Bartutis, 2003). His work had a significant impact on teaching and teacher training in a colonial context. Varela advocated for a secular education that departed from the predominant religious influence in the educational institutions of his time. He believed that education should be a universal right, accessible to all Cubans, regardless of their social origin. He promoted an educational approach that encouraged critical thinking and reflection among students. He believed that education should go beyond simple memorization, encouraging students to question and analyze their environment. He wrote numerous texts on pedagogy and educational philosophy, where he expounded his ideas on teaching and the role of the teacher. His works helped establish a theoretical framework for Cuban education, influencing generations of educators.

As discussed in the preceding paragraphs, elementary schools applied the Lancaster Schools method (Carrillo, 1946), in that teaching focused primarily on memorization and repetition. Although this approach facilitated a rapid transmission of knowledge, it limited the development of critical thinking and deep understanding. In this model, the most advanced students, known as monitors, were responsible for teaching their peers, which allowed a single teacher to supervise a large number of students (Estrada, 2012).

Classrooms were organized with long tables where several students sat. Each group of ten to fifteen children had its monitor, who was responsible for teaching lessons in subjects such as reading, writing and arithmetic. Discipline was strict and punishments and rewards were used to maintain order. A notable aspect of the Lancasterian schools is that they were open to all children without distinction of social class or gender, which contributed to the mass literacy of the population.



This model of teaching in Cuban primary schools in the 19th and 20th centuries sought to democratize access to education, however, it had its limitations in the quality of teaching, since it depended largely on the monitor, and if he lacked adequate pedagogical skills, the education received by his classmates could be deficient. Teaching focused on memorization limited the quality of education. Teaching focused on memorization limited the development of critical and creative thinking. This approach did not foster meaningful learning or a true understanding of concepts: monitors could abuse their position, transforming the classroom into a rigid and authoritarian environment. This generated tensions among students and could negatively affect their educational experience. Another aspect to be taken into account was, the physical conditions of the schools were not adequate, with poor lighting, poor ventilation, poor condition of the tables, among other deficiencies.

### **3 Mathematics in the Cuban primary curriculum**

The teaching of mathematics in Cuba during the 19th and 20th centuries was marked by diverse pedagogical influences and curricular changes that reflected both the social context and the predominant educational theories of the time. During the period of U.S. occupation in Cuba (1899-1929), the teaching of mathematics adopted an educational model that focused on traditional methods, prioritizing memorization and repetition. The first courses of study had a systematic focus on the teaching of Arithmetic, the science that studies numbers, their properties and the operations that can be performed with them (Aguayo, 1932).

According to Ariza (2014), the fundamental purpose of teaching Arithmetic at that stage was not to prepare students for mathematical advances, but rather to equip them with practical skills that they could apply in their daily lives. For Aguayo (1932) "In elementary school its aims or objectives are to teach how to solve calculations that are applicable to daily life and to exercise judgment and reasoning in its mathematical form" (p. 260). It should be noted that the textbooks used included simple problems designed so that students could apply what they had learned in elementary situations of their daily lives. Teachers were advised to read these problems and demand answers from students, focusing on common activities, especially those with a market approach.

In the teaching of arithmetic, the intuitive method was used in elementary classrooms to help children move from the concrete to the abstract. This approach combined analysis and synthesis, as well as variety and repetition of exercises. In addition, it included alternation between mental and written calculation, and sought to apply the knowledge acquired to the needs of everyday life, making learning more meaningful and applicable to students' daily experiences (Cartaya; Juanes, 1996). The problems had to address real situations and reflect everyday life operations. The data used had to come from contexts such as home,

commerce, industry and geography. In this way, not only did it achieve didactic value, but also enriched teaching by connecting mathematical concepts with everyday reality.

In line with the intuitive method, concrete materials such as abacuses and number boards were used to help students visualize mathematical concepts and perform calculations (Pedroso, 2009).

The last stage of the 19th century was the moment of analysis to simplify the methodology of teaching arithmetic in schools:

It is excused to warn that it is not a question of enlarging the number of branches in primary instruction, when we speak of improvements applicable to the needy class. These must fall on the simplification of methods to ensure more and more the success of teaching. (Luz y Caballero; 1950, p. 262).

In this regard, Aguayo (1932) notes that Grube's method (German teacher) did not go from one fundamental operation to another, but from one number of the natural series to the next number, advancing from one natural number to the next, starting with one and using objects to establish the notion of unity. This approach sought to connect mathematical concepts with concrete experiences. But that process entailed working in all six grades, exaggerating the objectivity of number and simultaneously teaching the four operations. A logical understanding of mathematical concepts was sought, although formal rigor was not yet predominant. Teaching focused on basic arithmetic, without delving into more advanced aspects.

On the other hand, in 1832, José de la Luz y Caballero presented the explanatory method and introduced it for the first time in the Colegio de Carraguao as an effective tool to encourage curiosity and the rejection of superficiality in the students. He considered that this was the only way to form true thinkers capable of contributing to the sciences and to the conscience that Cuba needed (Luz y Caballero, 1950), he makes clear that:

[...] the explanatory method will rescue the other mental faculties from the oppression in which memory has held them, then placing the latter at the disposal of the former. Yes, it will make us see in the tender creatures no longer some little repeating machines, but beings illuminated, although to a lesser degree, with the same light as their elders. (p.48-49).

As for the teaching of mathematics, he refers that “[...] the teacher will not be satisfied with just making them write, but, once the fundamental theorems of a subject have been explained, he will propose to the student’s problems capable of exercising their ingenuity and penetration” (Luz y Caballero, 1950, p.244). Therefore, he emphasized the importance of selecting appropriate exercises to help students to master procedures applicable in var-

ious future situations, emphasizing that the explanatory method has nothing mechanical because the questions can be different and vary to infinity.

Another method is that of Mariano Carderera (Carderera, 1863), who proposed an education that encompassed not only theoretical knowledge, but also its practical application, that is, an integral approach. His method emphasized the importance of connecting theory with practice, which allowed students to better understand the concepts. His approach included a specific methodology for teaching arithmetic, which was practical and oriented to facilitate effective learning in students (Ariza, 2014).

Carderera (1863) promoted the use of the experimental method in teaching (Aguayo, 1932). This implied that students actively participate in their learning through experiments and practical activities, which fostered more dynamic and meaningful learning. He emphasized the importance of adapting teaching methods to the individual characteristics and needs of students. This included considering their interests and social contexts, which made learning more relevant and applicable to their daily lives.

Some institutions adopted a cyclical progressive approach, where the same mathematical content was taught throughout primary education, gradually increasing in difficulty and complexity. The active method was also applied, from this perspective, practical and playful activities were included, encouraging the active participation of students in their learning process (Real; Segovia; Ruíz, 2009; Real, 2023).

These methods reflect an effort to modernize the teaching of mathematics in Cuba during the 19th century, seeking to make it more relevant and effective through practical and theoretical approaches that would connect with students' daily lives.

For Aguayo (1932) "The learning of arithmetic is an extremely complicated process that presents a multitude of psychological problems" (p. 266). Meanwhile, the prominent psychologist and educator Edward Thorndike (Thorndike, 1913) addresses the theories on learning that significantly influenced the teaching of arithmetic in the nineteenth and twentieth centuries. His approach focused on the application of psychological principles to the educational field, establishing methods that sought to improve the effectiveness of learning in mathematics. Thorndike (1913) proposed that learning is based on connections between stimuli and responses. This theory, known as connectionism, holds that students learn through repetition and practice, establishing associations in their minds between a mathematical problem (stimulus) and the solution (response) (Aguayo, 1932; Cruz, 2005).

According to Thorndike (1913), the law of effect reflects that responses that are followed by satisfactory consequences tend to be reinforced, while those that are followed by unsatisfactory consequences tend to be avoided. In the field of arithmetic teaching, this implies that students will be more motivated to solve problems if they receive rewards or positive reinforcement for doing so (Aguayo, 1932). He also emphasized learning through trial

and error, where students experiment with different solutions until they find the correct one. This method is especially useful in teaching arithmetic, as it allows students to try different approaches to solving problems until they gain an understanding of the underlying concept.

Thorndike (1913) stressed the importance of repeated practice and mechanization in the teaching of mathematics, arguing that systematic exercises are essential to consolidate the connections between concepts and their practical application. He promoted the use of concrete teaching materials, such as abacuses and number boards, to facilitate the visualization of concepts and improve the understanding of arithmetic operations. His structured approach not only transmitted knowledge, but also fostered a positive attitude towards learning, which had a significant impact on modern pedagogy.

Thorndike's (1913) theories led to a more practical and organized approach to teaching arithmetic in elementary schools. His emphasis on active learning and positive reinforcement helped to develop methods that sought not only to impart mathematical knowledge, but also to cultivate a favorable attitude toward learning. In addition, works dedicated to the teaching of mathematics with a utilitarian approach emerged, where authors such as Lavastre (1911) and Escalona; Miyares (1941) emphasized the importance of understanding the meaning of numbers and operations, introducing problematic situations to facilitate learning.

For Thorndike the contents of school arithmetic (Aguayo 1932, p. 269) were the following: 1) the significance of numbers; 2) the nature of our decimal number system; 3) the significance of the operations of addition, subtraction, multiplication, and division; 4) the nature and relations of certain common measures; 5) the ability to add, subtract, multiply, and divide integers, common and decimal fractions, and complex numbers; 6) the ability to apply the knowledge and skills referred to in paragraphs 1 and 5 to problem solving; 7) certain specific abilities to solve problems related to percentages, interest, and other matters of economic life.

The Board of Superintendents of Public Schools constituted the legal apparatus to establish the guidelines, methodological and curricular requirements of the curricula of Cuban public schools in the 19th and part of the 20th century. Mathematics is considered as one of the subjects under the name of Arithmetic with the purpose of “[...] educating and disciplining mental difficulties, and putting the student in a position to handle numbers, with sufficient skill, to calculate quickly and accurately the problems that arise in the ordinary course of life [...]” (Públicas, 1914b, p. 3). Then the teaching of arithmetic was based on principles of strict logic, with the objective of fostering a rigorous mental discipline (Padró, 1912).

According to Aguayo (1932), in the subject Arithmetic they worked from whole numbers to percentages, in which it is inferred that rational numbers are worked on. The introduction of numbers is based on the students' experiences. The concept of magnitude is introduced and operations with magnitudes are performed to introduce whole numbers, which

is an advance for its time. They are taught the table of calculations to multiply by up to 10. Children learn to count up to five-digit numbers by the fourth grade.

Regarding the use of written or mental method for calculations, Aguayo (1932) states the need to allow students to use the one with which they feel more comfortable. However, he recognizes that mental calculation should be carried out until the student memorizes the table and, subsequently, the manual method should be used as the safest way for students. Special attention is given to subtraction, since the complexity of the process is recognized, especially when a number in the minuend is greater than the subtrahend. The division is proposed to be studied in the following way in Figure 1.

**Figure 1** – Division between two numbers.

$$\begin{array}{r}
 3437 \overline{)28} \\
 \underline{-28} \quad 122 \\
 63 \\
 \underline{-56} \\
 77 \\
 \underline{-56} \\
 21
 \end{array}$$

Source: Authors elaboration.

Once the integers are known, we move on to rational numbers as quotients of integers. Portions of plots, pies and productions are studied as a way to introduce rationals, so that students can understand them. The application of these concepts is also done in a practical way, but oriented to an individual project. In the case of percentages no special distinction is made, except that they are divided by 100. The addition and subtraction of fractions is proposed using the least common multiple. When there are three numbers, the products of each one are sought and those that are divisible by the first, second and third are determined (Aguayo, 1932).

It is important to teach students the knowledge that is in the programs, but emphasizing these two elements that are a constant in the development of mathematics. In Brazil, there have been some isolated experiences in which the teaching of mathematical content has been carried out in which some initial steps are taken (Reis; Puentes, 2024; Puentes, 2023; Souza, 2023). However, they achieve this by pursuing another objective: the introduction of Elkonin-Davidov-Repkin didactic systems developers.

All these arithmetic processes were taught in an intellectualistic manner (Carrillo, 1946), which did not favor real practice. Another problem that hindered the teaching of math-

ematics in Cuba was the divorce with the development of this science. While the mathematical world was betting more and more on the development of logical rigor, the teaching of Cuban mathematics was carried out using inadequate languages and symbols.

The advent of relations with the CAME and the introduction of German teaching ideas would radically change this situation in the 1960s. Small demonstrations began to be carried out in elementary school with the contents that were being taught and the children appropriated the logical processes of mathematics.

In the same way, mathematics made use of increasingly complex abstraction processes in the different disciplines taught at school. The treatment of abstract concepts, such as point and straight line, became common in Cuban elementary school. The systematization of the best results of mathematics didactics was introduced in the training of mathematics teachers. The Higher Pedagogical Institutes were created in the 1960s and the higher education of teachers at all levels, including elementary school, began.

In 1978 the Cuban Society of Mathematics<sup>5</sup> was created, in which all those who had training in Mathematics were affiliated and later in 1988 the name was changed to Cuban Society of Mathematics and Computer Science<sup>6</sup>. In the first years, the society prioritized work related only to mathematics, and later, work related to the teaching of computer science was added. This implies that, at the country level, associations concerned with the teaching of mathematics are being established, in addition to the Ministry of Education itself. These achievements had an impact on the teaching of mathematics in the Cuban elementary school due to the constant activities that were carried out with the teachers at this level.

During these years, research on mathematics teaching flourished as a result of the return of professionals who went to train in Didactics of Mathematics in the former USSR and GDR. The discipline of Didactics of Mathematics was strengthened. Many of these researches, at doctorate level, were dedicated to primary education.

#### **4 Impact of 19th and 20th century Mathematics on current mathematics education in Cuban primary education.**

Arithmetic, according to Padró (1914), is "[...] one of the oldest sciences and its utilitarian aspect appears in remote days [...]" (p.6). This discipline, as mentioned above, oc-

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<sup>5</sup> The Cuban Mathematics Society was created under the protection of Law No. 1320 as a non-governmental organization by a group of professors from the Department of Mathematics of the University of Havana. Its main purpose is to bring together all the enthusiasts for this science and promote its development in Cuba.

<sup>6</sup> In 1988 the name was changed by decision of the Board of Directors at the national level of the Cuban Mathematical Society during its Third Congress, at the request of the professionals who worked on computing in the Faculty of Mathematics. Its fundamental purpose remains the same, but with the addition of Computation.



cupies a fundamental place in the primary education of that time, integrating also elements of Algebra and Geometry. The transformation of Arithmetic into mathematics during primary education throughout the twentieth century reflects a remarkable evolution, influenced by social contexts, educational policies and theoretical advances.

Between 1899 and 1929, Cuba established a public primary education system inspired by the North American model, where arithmetic became one of the main subjects. During this period, intuitive methods emphasizing visual representation and the use of objects were used to facilitate learning. The influence of behaviorism, especially the theories of Watson and Skinner, predominated, focusing on repetition and practice as key strategies for teaching (Pedrozo, 2009; Ariza, 2014).

Between 1930 and 1958, important works on the teaching of mathematics in Cuba emerged, promoting a more meaningful approach that integrated problem solving related to everyday and economic situations. With the Cuban Revolution (1959-1965), the educational foundations were nationalized and new didactic materials were introduced that sought to unify and improve mathematics teaching in all schools, adapting to the needs of the Cuban context. Throughout the 20th century, psychological theories evolved from behaviorism to more constructivist approaches, recognizing the importance of the social and cultural context in learning and promoting greater integration between disciplines in the school curriculum (Pedrozo, 2009; Ariza, 2014; Izquierdo; Sánchez; Villegas, 2020).

According to Chevallard (1998), the contents taught are based on the knowledge contents that emerge within the sciences. Therefore, it is essential to analyze the development of mathematics as a science in the period under analysis and its impact on teaching. According to Ribnikov (1987), mathematics underwent notable changes in all areas, the most important of which was the dismemberment of mathematical analysis into several disciplines: differential equations, the theory of real functions and complex variable functions. Another distinctive process is the increase in the scope of mathematical concepts resulting from a more general vision. A second process was the critical revision of the foundations of mathematics (definitions, axioms and the logical methods) to develop mathematics.

In Number Theory, the following were highlighted Carl Friedrich Gauss (Gauss, 1877) and Évariste Galois (Galois, 1899) stood out in Number Theory. Gauss (1877) published his main results in the book "Disquisitiones Arithmeticae", which laid the foundations of modern number theory. One of his fundamental contributions was the logical structure in the construction of the mathematical results that lasts until today. First, the results are presented, then they are rigorously proved and, finally, the corollaries or consequences are presented.

The 19th century was an important century for mathematics because of the high degree of rigor introduced by Gauss (1877) and Cauchy (1893), which was accepted by the

mathematicians of the time. The conjunct-theoretic foundations are laid and the notions of structures that have followed an accelerated development during the next century.

The 20th century was a period of great innovation in mathematics, characterized by the formalization and abstraction of concepts, as well as by the application of mathematics to new areas. Here is a summary of the main lines of development:

Regarding Algebra, especially set theory, development continued from the works of Gödel (1940) and Gauss (1877). These works served as a basis for increasing the formalization of mathematics. Another branch of mathematics, topology, was greatly increased from the works of Poincaré (1959) and Herstein and Milnor (1953) and were considered basic to understand various concepts in mathematics and theoretical physics (Rey Pastor; Babini, 1997).

One cannot fail to mention in the analysis of mathematics in the twentieth century Gilbert (1901). "He has imprinted his stamp and left his mark on all the vital questions of mathematics, from the analysis of its foundations and the highest chapters to the treatment of particular problems" (Rey Pastor; Babini, 1997, p. 164). In 1900, during the International Congress of Mathematicians, he presented 23 problems of this science that still continue to mark the fundamental lines of work of Mathematics. He is an advocate of Cantor's set theory (1915) and reformulated the theory of invariants, which is the one used today.

In summary, twentieth-century mathematics has two fundamental characteristics that have marked its rise since the nineteenth century: logical rigor and a high level of abstraction. In the first of these, emphasis has been placed on Gauss's proposal of the method of presentation of results, which has already been explained. Increasingly, mathematicians pay more and more attention to the ways of obtaining results and the logic followed in it. To this end, a precise, brief and unambiguous language has been structured. This language is constantly increasing with each mathematical discipline that is created, since each of them needs its own "alphabet" but not in contradiction with those already established.

The second, abstraction, has been increased from the separation of mathematics from the reality given by the senses to a science that, a good part of its development, is based on the construction of theoretical systems based on theoretical inferences. The beginning was commented previously: the negation of Euclid's fifth postulate. This process was validated from the verification of applications in reality of geometries obtained by purely deductive processes.

The two distinctive elements of the development of mathematics were not taken into account in primary education during the period analyzed. This led to the fact that the study of mathematics in Cuba in the 19th and 20th centuries was mainly devoted to solving problems related to civil engineering or agronomy. The mathematical exercises and problems were related to these sciences. The utilitarian character of mathematics as a subject was reinforced

and the fundamental elements of its development as a science were ignored. This meant that mathematics did not fulfill its fundamental function of developing logical thinking and abstraction (Torkildsen et al., 2023) and was not taught as an eminently deductive science.

Later, with the arrival of specialists trained in the GDR and in the former USSR, discussions on Mathematics as a science and its development in Mathematics as a subject began to take effect. The creation of the Cuban Mathematics Society, as explained in the previous section, was a great help in this process.

In 1972, the Higher Pedagogical Institutes were created in each province of the country, whose main objective was the creation of Bachelor's Degrees in Mathematics Education and others that responded to the teaching of secondary education subjects. In this career each discipline that was developed in the XIX and XX century becomes a set of subjects called discipline. The first curriculum of the career was called Plan A, later a curricular reform was carried out in the 80's with the Plan of Studies B and in 1990 Plan C was created where the Bachelor's Degree in Mathematics Education and Computer Science is studied. All of them are 5 years long. The transformations reached until 2016, when Mathematics and Computer Science were separated and independent four-year careers were created, called Study Plan E. The purpose of the profession was to teach Mathematics from elementary school to adult education.

All curricula, from A to E, contain within their curricula the disciplines Algebra, Geometry, Analysis, Statistics and Probability, where the fundamental contents of Mathematics and its advances in recent years are studied. Its teaching has been characterized by applying the two elements of Mathematics development in the period studied. There is also a discipline called Didactics of Mathematics in which the fundamental contents of the teaching of Mathematics for all levels, in which primary school has a special attention due to the impact it has on higher levels. The contents of this subject have been fundamentally nourished by the research results of professionals trained outside the country and their continuators. This has formed a Didactics of Mathematics of its own that has been nourished by the sources of mathematics and its teaching both internationally and nationally. It has also been nourished in an interesting symbiosis of study with its own Didactics formed with the rich Cuban pedagogical tradition. Exponents of the didactics of mathematics in Cuba are Sergio Ballaster (Benítez; Pedroso, 2013; Pedroso, 2009), Bernardino Almeida (Cuesta; Pino; Almeida, 2022; Pino; Almeida; Rosquete, 2024), among many others.

All these investigations have been reverted in the teaching of mathematics at all educational levels. Cuban primary education has been transformed, giving priority to the tension between the principles of abstraction and deduction inherent to mathematics and the level of development of students at that age. Today, Cuban students at this level of education are capable of making the abstractions and deductions necessary to understand

the fundamental concepts and theorems of the mathematical content they are studying. In addition, they are prepared to face subjects related to mathematics at a later level, such as physics and chemistry.

## 5 Conclusions

Primary education is characterized by work centered on the development of the student's personality. From this age, students begin to be interested in science or literature due to the division of subjects into these large groups. At this age they begin formal learning for the first time, outside the home and under the guidance of an adult other than their parents.

Primary education in Cuba from 1850 to 1950 was marked by two fundamental periods: the period of the wars of independence from Spain and the period of the Neocolonial Republic. In the first period, isolated schools were developed in which novel methods of teaching mathematics were implemented. These methods were introduced, in an isolated manner, by various teachers or in certain provinces such as Havana. The second period began a transformation at the national level with the creation of the Secretariat of Public Instruction and the approval of laws that modernized. These transformations laid the foundation for a more meaningful and life-applicable mathematics education. These transformations laid the foundation for a more meaningful and life-applicable mathematics education.

The teaching of mathematics in primary education, focused on logical rigor and abstraction, seeks to train students capable of critical reasoning and applying their knowledge in various situations. This approach not only improves mathematical skills, but also contributes to the integral development of students, preparing them to face academic and daily challenges.

In Cuba, the teaching of mathematics in elementary school during the 19th and 20th centuries evolved from a traditional, rote approach to more active, student-centered methods, influenced by contemporary pedagogical currents and changing social contexts.

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