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THE ORGANIZATION OF MATHEMATICS TEACHING
AT EARLY YEARS OF THE ELEMENTARY SCHOOL
IN BRAZIL

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Abstract. According to the Brazilian National Curricular Standards, Mathematics is a fundamental component of the education of citizens and it must be available to everyone [2]. This article strives to describe the organization of Mathematics teaching at the early years of the Brazilian elementary education. It presents the structure of the curriculum, highlights main methodologies used in mathematics teaching at this level of school education as well as discusses the creation of textbooks in Brazil. In order to overcome the problem of teaching quality, some proposals were offered by Brazilian researchers in the areas of Education and Mathematics Education, in relation to methodologies and didactic resources. Among these methodological proposals, Ethnomathematics stands out in Brazilian basic education. Formulated by Brazilian professor and researcher Dr. Ubiratã D'ambrósio, Ethnomathematics has as its foundation the study of Mathematics from different ethnic-cultural groups. For ethnomathematics, the teacher must perform a critical analysis of the mathematical contents, identifying its importance, necessity and objectives, searching the nature of Mathematics, starting from its history and its relations with society, to show the real needs and concerns of the other cultures at different historical moments. The article analyzes documents that guide an elementary education in Brazil, dissertations and theses, open access articles and scientific reports in the journals on Education and Mathematics Education.

Key words: elementary education; mathematical skills; mathematics teaching and learning; curriculum; didactic book of mathematics.

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**ОРГАНИЗАЦИЯ ПРЕПОДАВАНИЯ МАТЕМАТИКИ
В ПЕРВЫЕ ГОДЫ НАЧАЛЬНОГО ОБРАЗОВАНИЯ
В БРАЗИЛИИ**

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Аннотация. Согласно Бразильским национальным стандартам учебной программы, изучение математики является фундаментальным компонентом образования граждан и должно быть доступно для всех [2]. Данная статья предлагает описание организации обучения математике в первые годы бразильского начального образования. В статье представлена структура учебного плана, освещены основные методики преподавания математики на этом этапе школьного образования, а также рассмотрены вопросы создания учебников математики в Бразилии. В целях решения проблемы качества обучения, бразильскими исследователями в области образования и математического образования были разработаны некоторые предложения в отношении методик и дидактических ресурсов. Среди методологических предложений в бразильском начальном образовании выделяется этноматематика. Термин «этноматематика» был введен бразильским ученым, профессором Убиратаном д'Амброзио. Основой этноматематики является изучение и описание практической математики различных этнических групп. Учителю необходимо выполнить критический анализ содержания математики, оценить его важность, необходимость и цели, определить природу математики, начиная с ее возникновения, и ее отношений с обществом, чтобы показать реальные потребности и проблемы других культур в различные исторические моменты. В статье анализируются государственные документы о начальном образовании в Бразилии, диссертации, монографии, статьи и научные доклады в журналах «Образование и преподавание математики».

Ключевые слова: начальная школа; математические знания; преподавание математики; учебный план; учебник математики.

Introduction. The changes that have taken place in contemporary societies, in which the development of science and technology are highlighted, have had unprecedented effects on educational issues, reflected in the development of school curricula. The need for an education that provides the development of students' intellectual capacities becomes emerging. And as of "the relationship between teaching methods and child development, it is that teaching should anticipate and thereby stimulate cognitive development" [10, p. 15].

In Brazil, in the last thirty years there has been an intense movement of curricular reforms, which purpose is the adaptation of the country to the new world scenario, which requires an education focused on the development of skills and competences, that attends the process of production. Such requirements can be clearly seen in the "World Conference on Education for All", held in Thailand in 1990, which defined a basic education as a priority. Promoted and sponsored by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Bank (BIRD), the United Nations International Children's Emergency Fund (UNICEF) and the United Nations Development Program (UNDP) that Conference had a result of World Declaration about Education for All (1990), which presents guidelines and forms of regulation of educational policies in emerging countries in Latin America, Asia and Africa.

In this restructuring place of Brazilian education that is inserted in the National Curriculum Parameters (NCP), published in 1997, which purpose is to contribute to the construction of a quality education that is geared to meet the demands of the current world. Tavares [21] highlights five major themes that guide the Brazilian curricular problem: *education for citizens; constructivism, multiculturalism, evaluation and the quality of education.*

Methodology. The present research is based on bibliographical data from periodicals, books, dissertations/theses and articles in the areas of Education and Mathematics Education, documents and official discourses that guide Brazilian elementary education.

1. The National Curricular Parameters and the Mathematics Organization in Brazilian elementary education. As in many countries of Latin America and Europe, the teaching of Mathematics in Brazil presents aspects such as: an appreciation of problem solving; mathematical literacy; meaningful learning; a language specific to Mathematics, etc. In this sense, the NCP points out that one of the objectives for teaching Mathematics in Elementary School is "to identify mathematical knowledge as a means to understand and transform the world around them and to perceive the intellectual game character, characteristic of Mathematics, as an aspect that stimulates interest, curiosity, the spirit of research and the development of problem-solving ability" [3, p. 47].

The Brazilian Elementary School, in its current format, is divided into two cycles. The first one covers grades 1-5 (students from 6 to 10 years old) and the second grades 6-9 (students from 11 to 14 years old). The purposes of Mathematics, present in the curriculum for this level of education according to Oliveira [19], contemplates four dimensions: cultural, social, educational and political.

Cultural Dimension: mathematical knowledge is linked to cultural contexts, these are based on the ideas of Ethnomathematics.

Educational Dimension: Mathematics activity has as objectives the construction and appropriation of mathematical concepts by the students, who will serve these to understand and transform their reality.

Social Dimension: the social role refers to the insertion of the students in the labour market, as well as in social relations in general.

Political Dimension: refers to the importance of mathematics in the contemporary world, in which technological and scientific knowledge is given a priority.

The guidelines that guide the selection and organization of Mathematics contents in Elementary Education, follow the principles and norms stipulated by the National Council of Teachers of Mathematics – NCTM [15]. Thus, the contents are distributed in four blocks: *I) Numbers and Operations*, which involves the fields of Arithmetic and Algebra; *II)*

Space and Form, which studies the basic concepts of Geometry; *III) Greatness and Measures*, which allows to interconnect the fields of Arithmetic, Algebra and Geometry;

IV) Information Processing: which addresses basic concepts of Statistics and Probability. The summary of each block of contents is presented in Table 1.

Table 1

Summary of contents per block according to National Curricular Parameters

Таблица 1

Содержание образования согласно Бразильским национальным стандартам учебной программы

Block of Contents	Description
Numbers and Operations	Knowledge of natural and rational numbers (fractional representation and decimals) as effective tools to solve problem situations, considering their properties, relationships and how they were historically constituted. The work with the operations must prioritize the understanding of the different meanings of each of them, the connections between them and the reflexive study of the calculation, contemplating the types: exact and approximate, mental and written.
Space and Form	The geometric concepts favor the development of a special type of thinking, which allows the student to understand, describe and represent, in a systematized way, the world in which he/she lives. The work with geometric notions turns to the observation, perception of similarities, differences and identification of regularities, involving the analysis of objects of the physical world, art works, sculptures, crafts and drawings.
Greatness and Measures	The block is characterized by its strong social relevance, with evident utilitarian and practical character. The activities in which notions of magnitudes and measures are analyzed, provide a better understanding of concepts such as: proportionality and scale, meaning of numbers and operations, as well as the concepts of shapes and forms.
Information Processing	Associated with this block are the notions of Statistics, Combinatorial Analysis and Probability. The work with statistical measures includes procedures for collecting, organizing, interpreting data, through frequency tables and graphs. In the field of combinatorics, the goal is to lead the student to deal with situations involving the fundamental principle of counting. Probability studies focus on the understanding that most everyday phenomena present a random nature, and it is possible to estimate probable results of these events. The notions of chance and uncertainty, which manifest intuitively, can be explored through random experiments and observation of events.

Source: [3]

In the mid 90's, the Brazilian government introduced the pedagogical evaluation of didactic books, through the National Program of Textbook and Teaching Material – NPTTM, which began to guide authors about the distribution and organization of content by level of education. It is important to note that the books evaluated and approved by the program are in-

tended for public elementary schools. The structure of the mathematical contents in didactic books follows the same structure indicated in the NCP. The following pattern is defined as satisfactory for the first five years of Elementary School, based on Mathematics Education studies:

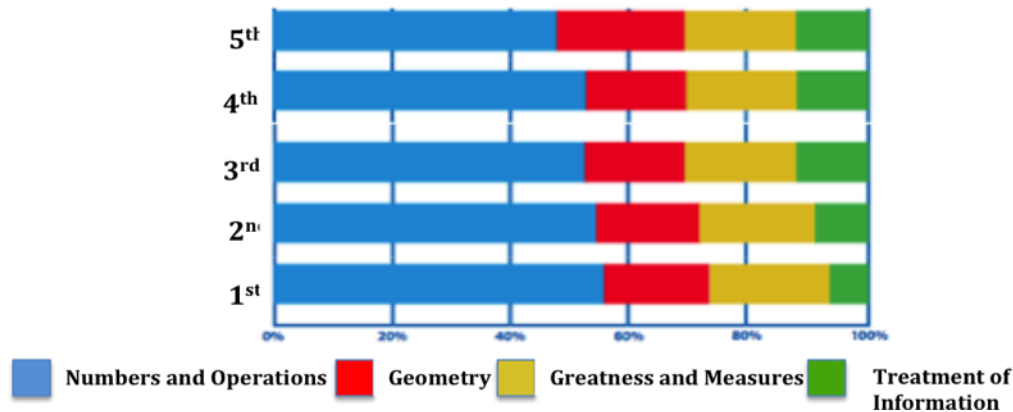


Fig. 1. Distribution of the mathematical contents suggested by the National Program of Textbook and Teaching Material 2016 for didactic books of the first years of Elementary School

Рис. 1. Распределение математического содержания по классам, предложенное Национальной программой учебников и учебных материалов в 2016 г. для учебников и учебных пособий начальной школы

Source: National Plan of Textbook [2]

2. Teaching Mathematics at the early years of Brazilian elementary education. One of the great challenges faced by Brazilian elementary education is the overcoming of 'technicalism', produced by a training aimed at training students to solve external evaluations. Authors such as Nacarato, Mengali and Passos [16] defend the idea of a curriculum for mathematics that is not limited to calculations and algorithms, or the memorization of formulas, as observed in didactic materials developed for basic education. According to the authors, it is necessary to rethink the basis of mathematical literacy, in order to develop in students the ways of thinking of Mathematics, correlating mathematical concepts with their various manifestations in everyday life.

It is important that “students are led toward explaining specific dependencies and making conclusions. Educational practice shows that children are fond of research work. They like to discover connections and make conclusions on the basis of their own observations” [13, p. 779].

Aiming to overcome the problems related to teaching quality, Brazilian researchers in the areas of Education and Mathematics Education have pointed out ways in relation of methodologies and didactic resources. Among the methodological proposals pointed out by Bieger [1], for example, are: *Mathematical modeling*, which consists of a process that starts from the

real, creating a model that seeks to explain reality, and from the obtained data, returns to the object of study, validating or reformulating the created model;

Ethnomathematics, which is based on the study of Mathematics from the different ethnic-cultural groups;

Problem Solving that, using everyday situations, aims to make the student protagonist of the process of building their own knowledge;

Games and modeling as a possibility for the development of creativity and autonomy, among others.

Mandarino [14], analyzing the classes of more than 100 teachers of mathematics from public and private schools, from the early years of Brazilian elementary education, sought to identify the mathematical contents worked at this level of education. The results show that schools in the public school system faithfully follow the guidelines described in the NCP. In contrast, the private network adopts an unofficial curriculum, based on content addressed in didactic books, traditionally accepted as more "demanding". Analyzing separately the emphasis given to each block of content, the author found that even when attending to students with a high socioeconomic level, the private education network did not have a big difference in terms of content distribution, as can be seen in the table below.

Table 2

Distribution of content blocks in public and private education networks

Таблица 2

Процентное распределение математического материала в образовательных системах государственных и частных школ

Block	Public	Private
Numbers and Operations	72,6%	78,9%
Space and Form	15,8%	14,3%
Greatness and Measures	3,7%	4,1%
Information Processing	7,9%	2,7%

Source: Mandarino [12, p.160]

The teaching methodologies present in basic education didactic books and, generally adopted by the great majority of Brazilian teachers, are summarized in the "problem solving", as guided by NCTM, and in "traditional teaching", which is characterized by the transmission of contents mathematicians through the presentation of concepts, property and procedures, followed by a set of activities, in which students must solve by following an example previously solved by the teacher.

Among the didactic resources used in the initial years games are playing very important role in the integration of the child into the school context, besides valuing the playful aspect of learning. "Through the game comes the child's comprehension of the world, of him/herself, of other people. The game takes a big place in the life of an elementary school student" [11, p. 11].

3. Mathematics didactic books for Brazilian elementary education. The widespread use of textbooks in Brazilian education was only possible, according to Silva [20, p. 132], "because it has become a highly profitable commodity". Its origin is linked to an elite, but its expansion only happened because that same elite turned it into a business. The conditions for the expansion of this commodity, occurred through the State, in a relation of negotiations and concessions of both parties.

According to data from the National Fund for Education Development – NFED, in 2017 more than 152 million textbooks were distributed to Brazilian students of elementary school of Public school system of elementary and sec-

ondary education, in all units of the Federation. Expenses of publishing were 1,296 mln Brazilian reals (about US \$357 mln) [7].

In the 1971, the book of Mathematics appeared in a political context of Military Dictatorship and North-American influence represented by agreements between the Ministry of Education and the United State Agency for International Development (USAID), a partnership that lasted from 1964 to 1976. In the field of the teaching of mathematical concepts, the technicalism and theoreticism prevailed, marked by the Modern Mathematics Movement.

In the mid 90's, the Mathematics textbook was located in a democratic context, where the teaching of Mathematics, seeking alternatives to improve the quality of teaching, seeks in constructivism, in learning, in teacher-student relations, in Ethnomathematics, in the modeling and interdisciplinarity, means to favor the appropriation of the mathematical concepts by the students.

Nowadays, the Mathematics textbook, intended for Brazilian public schools, plays a role of reference and organizer of teacher work in the classroom. Created for the first years of Secondary school, the books approved by NPTTM 2016 highlight the importance of the first years of this phase and one of its objectives is to "develop in the young apprentice progressive autonomy in studies" [2, p. 10]. Submitted to a curricular reorganization, the document establishes two stages for the first five years of Elementary School. The first one, constituted by the first three years, emphasizes that Mathematics has as its focus the "gradual

organization of it first experiences with mathematical ideas and procedures. All this, in conjunction with the development of their intuitive knowledge of the natural world and the social context" [2, p. 10]. In relation to the second stage, the objective is to lead the student to consolidate the process initiated in the previous stage, offering him/her the conditions to develop his/her "capacity to mobilize mathematical knowledge in everyday practical situations" [2, p. 11]. Thus, in accordance with the two stages, the Guide offers two types of works: collections of *Mathematical Literacy*, destined to the first three years and collections of *Mathematics*, for the 4th and 5th year.

For the development of mathematical skills, a set of skills are proposed by the didactic books, such as:

- interpret mathematically everyday situations or other areas of knowledge;
- use independently mathematical reasoning for understanding the world around us;
- solve problems, create strategies for their resolution, and develop initiative, imagination and creativity;
- evaluate whether or not the results obtained in solving problem situations are reasonable;
- reasoning, making abstractions based on concrete situations, generalizing, organizing and representing;
- understand and transmit mathematical ideas, in writing or orally, developing the capacity for argumentation;
- use mathematical argumentation based on several types of reasoning: deductive, inductive, probabilistic, by analogy, plausible, among others;

- to develop sensitivity for the relations of Mathematics to aesthetic and play activities;
- use new computing and information technologies, among others.

These skills should be developed in an articulated way with the competences associated to the mathematical contents of the 1st to 5th year. The most effective methodological path, capable of developing such skills and abilities, should be problem solving, as also guided by NCTM. However, as NPTTM 2016 points out, "a problem is not an activity of simple application of techniques and procedures already exemplified. On the contrary, it is an activity in which the student is challenged to mobilize his/her mathematical knowledge" [2, p. 16]. The appropriation of concepts should occur individually with the help of colleagues or the teacher. It is important to monitor the development of skills and abilities. "L.S. Vygotsky formulated a number of fundamental principals of conducting the diagnostic studies, which we still use today" [12, p. 4].

In a study of Mathematics textbooks, aimed at the basic education of Brazil, Russia, Japan and other countries, Tomm [22] points out that one of the great problems of Mathematics textbooks, for the initial years in Brazil, correspond to the volume of contents and chapters. The volume of subjects, according to the author, makes it impossible for the students to deepen their fundamental content. In this sense, it is possible to verify this affirmation when comparing one of the Mathematics textbooks, approved by the NPTTM 2016, with a book approved and adopted for the same level of education in Singapore.

Table 3

Comparison as to the number of chapters in Mathematics textbooks for the first years of Elementary Education in Brazil and Singapore

Таблица 3

Сравнительный анализ количества глав в учебниках математики для начальных классов в Бразилии и Сингапуре

Initial Years (Elementary School)	Brazil (Number of chapters per textbook)	Singapore (Number of chapters per textbook)
1st	20	21

2nd	32	15
3rd	37	15
4th	41	11
5th	44	13

Source: Geovanni Jr. [8]; Fairfield Book Publishers Singapore [6]

It is important to note that according to the Trends in International Mathematics and Science Study – TIMSS [15], which monitors the educational performance in Mathematics and Sciences of 57 countries, in its last report of 2015 highlights that the best results in Mathematics are from Singapore, the country was in 1st place with 618 points. Brazil does not par-

ticipate in TIMSS. The only international evaluation that monitors the performance of Brazilian education is Programme for International Student Assessment (PISA). The performance of Brazilian students in PISA 2015 in Mathematics in the last 15 years of evaluation can be observed in the graph:

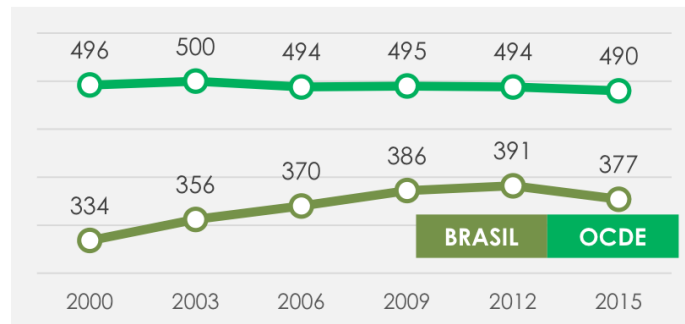


Fig. 2 Comparison between the averages of Brazil and the Organisation for Economic Co-operation and Development countries in Mathematics

Рис. 2 Сравнительный анализ средних показателей по математике в Бразилии и странах Организации Экономического Сотрудничества и Развития

Source: [20, p.2]

Although not presenting significant results in Mathematics, compared to the OECD countries, in relation to the other disciplines evaluated, Mathematics presented the best evolution. However, according to the OECD, the average performance of Brazilian students remains at a very low level, which does not guarantee full participation in social life [7].

Final considerations. This paper presents an analysis of the main documents that regulate the teaching of Mathematics in the initial years of Brazilian basic education, as well as the distribution of mathematical contents of blocks and the textbook policies through the National Textbook Plan. It was verified that the organization of the contents and the methodological principles adopted in the initial years of the Brazilian Elementary School, follow the

guidelines of the NCTM [17], and that although the curricular guidelines emphasize the importance of developing, in the students, skills and abilities mathematics through problem solving, external evaluations find unsatisfactory indices. In this sense, the research presents one of the factors that can favor, among others, the low performance of the students, which is the question of the volume of contents and organization of the student textbook.

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