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Probability and Statistics in the Early Years of Primary Education according to the National Core Curriculum

Probabilidade e Estatística nos anos iniciais do Ensino Fundamental a partir da Base Nacional Comum Curricular

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Abstract

The social demand for understanding and interpreting the most varied information, which is part of our daily life, made it essential to include probability and statistics in primary education. This paper aims to analyze pedagogical proposals developed for teaching probability and statistics in the early years of primary education considering the current National Core Curriculum - BNCC. This is a qualitative study with a bibliographic method, in which three master dissertations of researchers from the Working Group on Statistical Education - WG12, of the Brazilian Society of Mathematical Education, were selected and analyzed. The results show that these proposals encourage the students' investigative spirit and creativity, critical analysis and logical reasoning. In addition, they provide for the progressive development of skills and enable work in articulation with the general competencies of the BNCC.

Keywords: Teaching Probability and Statistics; Early Years of Primary Education; National Core Curriculum; Pedagogical Proposals.

Resumo

A demanda social por compreender e interpretar as mais variadas informações que fazem parte do nosso dia a dia tornou imprescindível a inclusão da Probabilidade e Estatística na Educação Básica. O presente artigo tem por objetivo analisar propostas pedagógicas desenvolvidas para o ensino de Probabilidade e Estatística nos anos iniciais do Ensino Fundamental a luz da Base Nacional Comum Curricular - BNCC. O estudo é de natureza qualitativa e de método bibliográfico, no qual foram selecionadas e analisadas três dissertações de mestrado de pesquisadores do Grupo de Trabalho em Educação Estatística - GT12 - da Sociedade Brasileira de Educação Matemática. Os resultados mostram que essas propostas fomentam o espírito investigativo e exercitam a criatividade, a análise crítica e o raciocínio lógico dos alunos. Além disso, proporcionam o desenvolvimento progressivo das habilidades e possibilitam o trabalho articulado com as competências gerais da BNCC.

Palavras-chave: Ensino de Probabilidade e Estatística; Anos Iniciais do Ensino Fundamental; Base Nacional Comum Curricular; Propostas Pedagógicas.

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Introduction

Statistics and probability are present in various contexts of our daily dealings and professional activities, such as medical and biological sciences, administration, finance, sales forecasts, demographic studies, quality control, among others. Nowadays, their study permeates the most diverse fields of knowledge. They are applied to verify facts, read and interpret data and information, establish relationships, make assumptions which allow us to understand that uncertainty, unpredictability and variability are present in the daily lives of people.

The variability present in the phenomena investigated shows the presence of statistics, however, it is probability which deals with the influence of randomness and measures the inherent uncertainty of statistical processes. Therefore, the knowledge of statistics and probability is intertwined. (Lopes & Mendonça, 2016). In education, probability and statistics are gaining space, and currently comprise one of the five thematic units of the National Core Curriculum[3] (BNCC) of mathematics for primary education. Each thematic unit includes a set of objects of knowledge, which are related to a range of skills to be worked on during elementary school (ES), in order to ensure the development of the general and specific skills provided for at that educational level.

It is not enough for students to know how to calculate statistical measures, build graphs and tables, they must know how to interpret and evaluate statistical information in each context. For Gal (2002) the student must develop statistical literacy, in order to acquire the proficiency to discuss and communicate their understanding of statistical information. In turn, the domain of probability requires familiarity with several concepts such as randomness, independence, uncertainty, probability or risk (Gal, 2005). Moreover, for that author, probabilistic literacy allows the student to deal with a range of real-world situations that involve interpretation or generation of probabilistic messages, as well as decision making.

Despite its importance and presence in the school curriculum, teaching probability and statistics is a challenge for teachers, especially for those who work in the early years of elementary school, who, for the most part, have not fully mastered this content. Such difficulty can be explained by the fact that, in general, teacher training courses for the early years of primary education rarely contemplate statistics and/or probability, as pointed out by Conti, Nunes, Estevam and Goulart (2019).

In an attempt to reverse this situation researchers[4] of the Working Group in Statistics Education – WG12 (*Grupo de Trabalho em Educação Estatística* - GT12), members of

[3] *Base Nacional Comum Curricular* (BNCC) - The National Core Curriculum is a normative document, issued by the Brazilian Ministry of Education, which defines the essential knowledge all students must develop throughout primary education.
[4] http://www.sbembrasil.org.br/sbembrasil/index.php/grupo-de-trabalho/gt/gt-12

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Brazilian Society of Mathematics Education (*Sociedade Brasileira de Educação Matemática - SBEM*), have carried out investigations and promoted the continuous education of teachers who teach statistics and probability in primary education. As a result of such investigations, pedagogical proposals have been developed in order to prepare teachers to work with the probabilistic and statistical concepts provided for in official documents for this level of education. However, the socialization and dissemination of successful investigations carried out in the academic environment often do not reach teachers in the primary education system and, as result, are not converted into materials to assist teachers. (Cazorla, Kataoka & Silva, 2010).

Thus, the present paper aims to analyze pedagogical proposals developed for teaching probability and statistics in the early years of elementary school, as per the current guidelines for primary education of the National Core Curriculum (BNCC). To this end, we analyzed the productions of members of the WG12 focusing on master's dissertations. We hope that divulging and reflecting on these pedagogical proposals will help teachers at this level of education plan and develop their classes.

This text is organized in six sections. In the first section, we introduce the proposal of the paper, then, present the methodology; in the third section, we discuss the teaching of probability and statistics within the primary education curricula; in the fourth section, we show pedagogical proposals elaborated for teaching probability and statistics in the early years of elementary school which meet the proposal of the National Core Curriculum (BNCC); finally, in the fifth section, reflections on such proposals and some considerations will be presented.

Methodology

This is a qualitative research, conducted with the bibliographic method. For Deslandes, Gomes and Minayo (2010) qualitative research enables the understanding of the multiplicity of senses and meanings present in reality, as well as the examination of motives, aspirations, beliefs, values and attitudes, understood as part of social reality. According to Bicudo (2014), this modality of qualitative research has prevailed in the humanities, especially education, because it enables the study of individual experiences lived and/or reported, and description of contextualized situations. The method is bibliographic in the sense that it uses materials prepared by different authors about the topic (Gil, 2008).

The methodological decision to base the analysis contained in this paper on dissertations is anchored in the comprehensive theoretical and methodological consistency of the works produced within the scope of *specialized* postgraduate courses. This occurs since they are usually constituted under the guidance and support of a research group, having been presented and accepted by examining committees. In addition, due to their greater theoretical scope, consistency and depth, they enable the revision of scientific production dispersed through multiple media (Santos; Fiorentini, 2016). It must be emphasized that some of the

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dissertations mentioned were planned before the publication of the BNCC. Therefore, our intention in the present study is to highlight the potential of the proposed activities in satisfying the general competence requirements of the current Brazilian regulation for primary education, which was a criterion for selecting the dissertations presented herein.

In order to start the research, we read the National Curriculum Parameters (PCN), the first official document to include probability and statistics in primary education; as well as the BNCC, the current reference which guides the organization of the curricula for all schools in the country. In such documents, we identified the objects of knowledge and the skills which should be developed with students regarding probability and statistics at this level of education.

Using the website of SBEM, we analyzed the list of researchers who were members of WG12[5]. After that, in order to identify dissertations which focused on teaching probability and statistics in the early years of elementary school we analyzed the *lattes curriculum*[6] of such researchers. Among the 38 members of the WG[7], 16 conducted their dissertations in statistical education. Among those 16 dissertations, 11 deal with statistics and 5 with probability, encompassing various academic levels. For the present study, amid those dissertations, we selected two which address statistics in the early years of ES. Regarding probability, none of the five dissertations found were within the proposed scope of this paper. Thus, we looked for dissertations, which focused on probability, that had been supervised by one of the five above-mentioned researchers. Of the 13 research projects found, only one presented a pedagogical proposal for teaching probability in the initial years of elementary school, which detailed the development of activities, as well as the students' manifestations while carrying them out.

Detailing of the planning and development of activities, based on theories and references of statistical education, and the difficulties faced by students in carrying out the tasks were part of the criteria adopted for the selection of the dissertations presented here. Such detailing meets the objectives of this paper with regard to highlighting the potential of such activities to promote the construction of students' probabilistic and statistical knowledge in the early years according to BNCC requirements.

Teaching Probability and Statistics in the Primary Education Curriculum

Initially, the study of probability and statistics was restricted solely to higher education. However, due to social demand for understanding and interpreting various pieces of

[5] The choice of scientific productions of WG12 results from the fact that this SBEM working group brings together researchers whose focus is statistical education.

[6] Lattes Platform is an information system maintained by the Brazilian federal government which contains information on science, technology, and innovation, related to research conducted by individuals and institutions in Brazil.

[7] Search conducted on the website of SBEM in September 2019.

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information, which are part of our daily lives, it has become essential to include the teaching of this content in primary education, in order to equip students for fully exercising citizenship.

In the United States of America, in the 1980s, the National Council of Teachers of Mathematics (NCTM) presented, in a document entitled "Agenda for Action", recommendations for teaching mathematics in primary education. Such recommendations in turn sparked discussions regarding mathematics education in different countries, which resulted in proposals for changes in the mathematics curricula, which also included aspects related to teaching probability and statistics in primary education (Lopes, 1998).

In Brazil, in 1997 and 1998, the publication of the PCN, gave rise to concerns regarding the inclusion in the mathematics curriculum of ES of probabilistic and statistical concepts, in addition to studies in the fields of arithmetic, algebra, geometry, quantities and measurements.

> A closer look at our society shows the need to add to these contents that allow citizens to "treat" the information they receive daily, learning to deal with statistical data, tables and graphs, and reason using ideas related to probability and combinatorics (MEC, 1997, p.53).

In the PCN for elementary school mathematics contents appear organized in four blocks, as follows: numbers and operations, space and form, quantities and measurements and treatment of information which must be worked on from the initial years of elementary school. The "treatment of information" block calls for the integration of studies regarding notions of statistics, probability and combinatorics. The inclusion of such topics in the PCN is justified by the importance of using these themes in today's society (MEC, 1997; 1998). Such documents are structured in cycles. This level of education consists of four cycles: 1st cycle (1st and 2nd grades), 2nd cycle (3rd and 4th grades), 3rd cycle (5th and 6th grades) and the 4th cycle (7th and 8th grades).

In the block of content entitled "Treatment of information", in the 1st and 2nd cycles, it is recommended that students begin to explore basic statistical ideas by learning to collect and organize data in tables and graphs, in order to establish relationships between events, make predictions and observe the frequency of occurrence of an event. In the 3rd cycle, it is recommended that students expand such notions, so that they learn to formulate relevant questions for a particular set of information, elaborate some conjectures and communicate information in a convincing way, interpreting diagrams and flowcharts, in addition to expanding the exploration of possibilities to quantify uncertainties. Finally, in the 4th cycle, students are already able to conduct surveys regarding their own reality and interpret it, using graphics and some statistical measures. While studying probability, it is important that students realize that, through experiments and simulations, they can indicate the possibility of occurrence of a certain event and compare it with the predicted probability through a mathematical model. (MEC, 1998).

Moreover, regarding the teaching of mathematics in the early years of elementary school, in 2014, the federal government launched *Pacto pela Alfabetização na Idade Certa*

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(Pact for Literacy at the Right Age - PNAIC) for mathematics. The teaching materials of that program address the idea of mathematical literacy from the perspective of literacy, in line with the proposal which underpins the materials for language.

The training process developed by PNAIC is organized into eight units, and each of them has support materials gathered in "formation notebooks". Among such notebooks, the one entitled "Statistical Education and Mathematical Knowledge" addresses statistical literacy and aims to present statistical education, providing the teacher with elements for planning pedagogical practices which help children recognize and produce information, in various situations and different configurations (MEC, 2014).

This notebook seeks to introduce the child to the universe of investigation, from situations relevant to them, performing data collection and representing them through graphs and tables. It also discusses probabilistic reasoning that can be fostered through playful situations by developing simple concepts, helping the child identify greater or lesser chances of occurrence. (MEC, 2014).

Currently, after the promulgation of National Core Curriculum (BNCC) in 2017, probability and statistics constitute one of the five thematic units in the field of mathematics for elementary school and must be worked on from the initial years of primary education. BNCC is a normative document that defines the organic and progressive set of essential learning that all students must develop throughout the stages and modalities of primary education [ ]" (MEC, 2017, p.7).

The goal of BNCC is to offer comprehensive education to students. This education is consolidated into ten general competences which encompass all dimensions – either cognitive, social and emotional – of the individual that must be developed throughout primary education. Directly linked to the general competences are the specific competences for each area of knowledge, also the respective curricular components that form such areas. In addition, to ensure the development of these specific competences, each curricular component brings a set of skills, related to different objects of knowledge (concepts, contents and processes) organized in thematic units.

According to the BNCC, the thematic unit for probability and statistics regarding elementary school deals with uncertainty and data treatment, and approaches concepts, facts and procedures present in many problem-solving situations of everyday life, science and technology (MEC, 2017).

> Thus, all citizens must develop skills to collect, organize, represent, interpret and analyze data in a variety of contexts, in order to form well-founded judgments and make appropriate decisions. This includes reasoning and using concepts, representations and statistical indexes to describe, explain and predict phenomena (MEC, 2017, p. 274).

Regarding statistics, the BNCC highlights that the first steps involve working with data collection and organization from research which is of interest to students.

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> Reading, interpretation and construction of tables and graphs, as well as the manner of producing written texts, play a fundamental role for the communication of data, as it is necessary to understand that the text must synthesize or justify conclusions (MEC, 2017, p.273).

Lopes (2003) emphasizes the importance of teaching and learning statistics through research with real-life themes which are meaningful for students. This is also ratified by the BNCC through detailing of the skills to be developed in the initial years of elementary school (Table 1).

Table 1: Skills to be developed in the initial years regarding statistics

Year	Skills
1st	- reading statistical tables and column graphs; - conducting research, involving up to two categorical variables of interest to students in a universe of up to 30 elements and organizing data through representations.
2nd	- comparing information from research through double-entry tables, simple column and bar graphs; - conducting research, involving up to three categorical variables of interest to students in a universe of up to 30 elements, organizing and presenting data through lists, tables and column graphs.
3rd	- problem-solving with data presented through double-entry tables, column and bar graphs; - reading, interpretation and comparison of data presented double-entry tables, simple column and bar graphs, generated based on the results of research of interest to students, using statistical language in order to understand the aspects of their sociocultural reality; - conducting research, involving categorical variables of interest to students in a universe of up to 50 elements, organizing the data collected through lists, tables single and double-entry tables and simple column graphs, with and without the use of digital technologies.
4º	- elaboration and resolution of problems involving ethical, conscientious and responsible consumption; - analysis and production of texts about the data presented in single or double entry tables as well as column or pictorial charts; - conducting research on categorical and numerical variables organizing the data collected through tables and graphs of single or grouped columns, with or without the use of digital technologies.
5º	- interpretation and production of texts regarding statistical data, tables and graphs (columns or lines), in various contexts; - conducting research on categorical and numerical variables organizing the data collected through tables and column graphs, pictorial and line charts with or without the use of digital technologies, as well as the production of texts containing summaries of research results.

Font: MEC (2017, p. 281-297)

Regarding the study of notions of probability, the BNCC points out that the aim for the early years of elementary school is to promote the understanding that not all phenomena are deterministic. Therefore, the early work on this theme is centered on developing the notion of randomness, so that students understand that there are events which are certain, impossible and possible (MEC, 2017). The document also highlights that in the early years, it is important for students to verbalize, through events that involve chance, the results that could have happened in opposition to what actually happened, thus starting to construct the sample space (MEC, 2017). Table 2 shows the skills related to the objects of knowledge regarding probability expected for this level of education.

As can be observed, the BNCC confirms the need to study probabilistic concepts, in the early years of elementary school, in order to favor the above-mentioned construction of basic notions, such as the perception of chance, the idea of random experience and the notion of

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probability. For Batanero and Borovcnik (2016), continuously teaching statistics and probability, throughout schooling, can help students progressively construct such knowledge. As a result, this will contribute to the formation of citizens who are able to understand random phenomena present in different real-life situations, as well as make appropriate decisions when faced with uncertainty.

Table 2: Skills to be developed in the initial years regarding probability

Year	Skills
1º	- Classify events involving randomness, as certain, likely, and impossible in everyday situations.
2º	- Classify results of random daily events as highly unlikely, highly likely, unlikely and impossible.
3º	- Identify, among random events, all possible results, estimating those which are more or less likely to occur.
4º	- Identify, among random events, all possible results, estimating those which are more or less likely to occur, recognizing characteristics of more probable results, without using fractions.
5º	- Define the sample space, present all possible results from a random experiment, estimating if these results were equally possible or not. Calculate probability. - Determine the probability of occurrence of a result in random events, when all possible results display the same chance of occurring.

Font: MEC (2017, p. 281-297)

For Serrazina (2014, p. 1066) "the education of teachers who teach mathematics in elementary school is a complex and challenging task for all those involved." For the author, changing practices implies changing conceptions and beliefs, regarding teaching and learning mathematics, which often coexist with the teacher's lack of confidence in how to approach such concepts in the classroom. The case of probability and statistics is not different, considering that, in general, teachers in the early years do not work with these concepts in their initial training. In view of the perception of the lack of continuing education courses which address probabilistic and statistical concepts, this paper aims to analyze pedagogical proposals developed for teaching of probability and statistics in the early years of primary education in the light of the BNCC.

In order to do so, we selected three master's theses which contained pedagogical proposals that seek to involve elementary school students in the investigative process inherent to statistics, and in the playfulness present in games used for learning probability. In the next section, the pedagogical proposals presented in such dissertations will be introduced.

Pedagogical Proposals Developed by Statistical Education Researchers

From reading official documents, we realized there was a need to introduce elementary school students to the universe of investigation, so that they can collect data and present it through tables and graphs, as well as knowing how to interpret information disseminated through such records. Moreover, it is important that the topic search is part of the daily life of the students, starting from something that they are curious and interested in investigating.

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Thus, initially, we selected two research-based master's dissertations conducted by teachers/researchers, members of WG12. In order to work with statistical concepts, those dissertations developed pedagogical proposals. We did not find any dissertation focusing on elementary school regarding concepts of probability among the members of the WG12. Therefore, we chose to analyze the dissertations supervised by members of the WG12. Then, we selected two pedagogical proposals from a professional master's thesis, supervised by a WG12 researcher, which explored playfulness used for understanding probabilistic concepts. Below, we present each of such proposals and discuss their planning.

Students' habits and tastes

The master's dissertation entitled "Statistical Education in Childhood", submitted in 2007 by Antonio Carlos de Souza, described the planning and development of a didactic-pedagogical proposal for approaching statistics in early childhood education. This proposal was based on the work of Batanero (2000; 2002); Garfield and Gal (1999), and Lopes (1998, 2003). The study was carried out with 17 students, aged 5 to 6 years, in a municipal school in the city of Suzano, state of São Paulo. Although the project was developed with early childhood education students, we understand that it is suitable for the early years of primary education and, therefore, it is in line with the activities discussed in this paper.

Lopes (2003) believes that conducting experiments that involve the experience of collecting, representing and analyzing data can render statistical concepts more meaningful for students, thus expanding their universe of competences, even more so when they are part of the students' background. The opportunity to work with real data can help students develop meaningful reasoning, which is in line with what Garfield and Gal (1999) quote in relation to the recommendations, published by the NCTM, in 1989. Similarly, Batanero (2002) points out that the development of knowledge is the purpose of education as much as the emotional side, which encompasses feelings, values and attitudes.

The research interrogation of Souza's research (2007) arose from the visit of an officer of the city administration of Suzano-SP to the school. They collected data (such as in question 4, Figure 1) about the students' opinions regarding school meals. In that poll, the "*emojis*" meant, respectively, great lunch, good lunch and bad lunch.

Students were curious about their classmates' responses regarding school meals, as well as those of other students. Discussions about the research activity that would be later carried out by the class originated from this curiosity. Such discussions arouse even more curiosity among students, which led to the creation of questions for the elaboration of the data collection instrument, such as: "Do you like the school?" and "How do you come to school?", as well as about students' bedtime (Figure 1). As both interviewers and interviewees did not yet know how to read and write, the answers to the questionnaires were represented pictorially.

While choosing the items for que questionnaire, the students had to revisit certain

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mathematical concepts previously worked on, such as the notion of time and position:

> as in question number eight of the questionnaire (living near or far from school). It was clear to the students that "near" and "far" depend on a reference, in this case the school. We realized this when it was suggested that we draw two houses: one near and one far from the school. [...]. In this question, it was also possible to notice a dash of inference, made by a student named Guilherme, who pointed out that waking up time could be related to the distance from the student's house to school and/or the means of transportation used to travel the respective route (Souza, 2007, p. 102).

In addition to those, other concepts[8] already worked on by the students were mobilized in the conduction of the activity, such as quantity, correspondence, counting and classification. During data collection, students worked in pairs, one in the role of assistant and the other of interviewer, whereas the teacher/researcher was responsible for coordinating the work. The data were initially represented through tables, and later through column charts, as they are more suitable for working with students at this age group. One of the axes of the graph presented the figure referring to the responses and the other the number of respondents. (Figure 2).

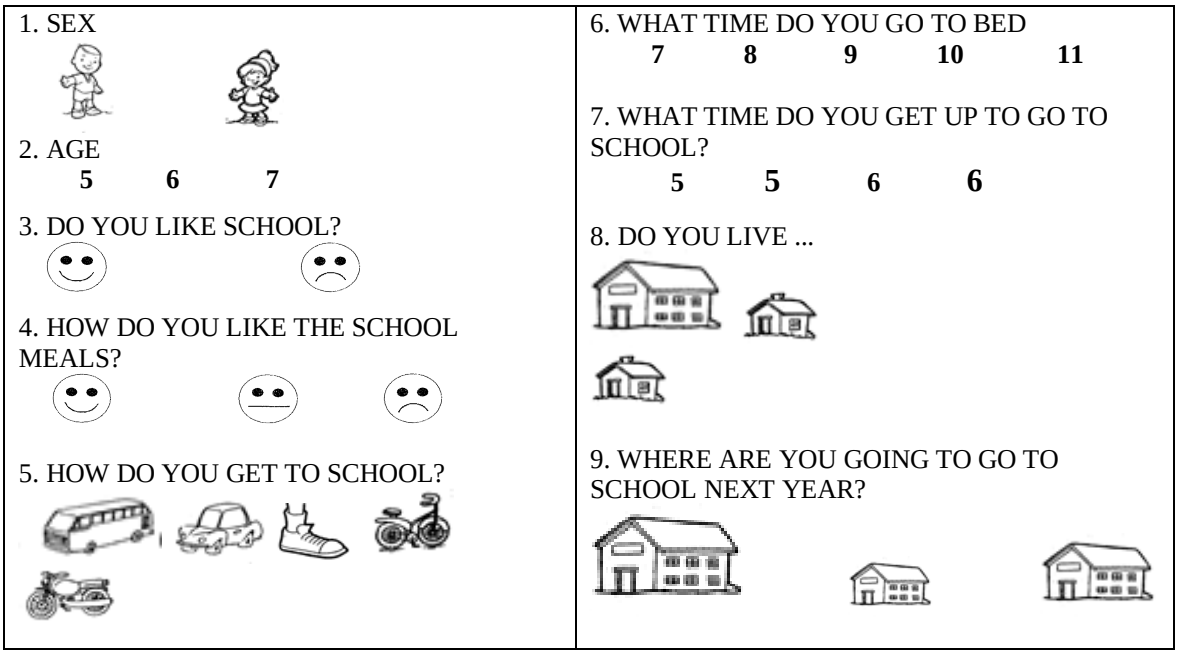

Figure 1- Final version of the questionnaire
Font: Souza (2007, p. 101)

One of the students pointed out that they had not interviewed all colleagues in the morning shift, which also makes it possible to explore concepts of population and sample. Such observation by the student was possible considering that he participated in the entire investigative process, from the choice of topic to the representation of data. The students'

[8] More details can be found in Santos (2006, p. 72-73)

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engagement and excitement in carrying out research show the importance of their participation in the entire process.

Figure 2 – Graphic representation of the items 4, 5 and in the questionnaire.
Font: Souza (2007, p. 147)

In the analysis of the data Souza (2007) found that the investigation conducted by the students enabled the use concepts which had already been built, the acquisition of new mathematical knowledge and the importance of context when approaching statistics. For the author, this work proved the viability of the development of statistical ideas in early childhood education.

Students' names and ages

Roberta Buehring in her master's thesis entitled "*Análise de dados no início da escolaridade*" (Data Analysis in Early Education), accepted in 2006, developed a didactic sequence to deal with the basics of data analysis in the 1st year of PE. She sought support in the theory of Register of Semiotic Representations, from the perspective of Raymond Duval in order to do so. According to Duval (as quoted by Buehring, 2006), the same mathematical object can be represented by means of records of different representations, without losing its reference, since mathematics allows for a variety of representations, such as numbering systems, geometric figures, algebraic writings and graphic representations.

In her research, in order to learn about the work that could be developed with children in the first year of PE, Buehring (2006) initially performed a didactic pre-sequence, based on the theoretical framework. The four activities proposed were conducted during an hour and a half on four consecutive days (Table 3).

The activities developed aimed to help students have contact various records of semiotic representations leading to the transition from one record to another, so that students can understand the difference between the representation record and what the person wants to

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represent. Although coordination between records is not a spontaneous activity, it is required for cognitive functioning, thus it is up to the teacher to develop activities that enable students to understand it (Buehring, 2006).

While conducting the activities, the students were free to collect data. Each student performed the task in a different way, which resulted in some difficulty. One such difficulty arose while counting the number of boys and girls in the class, as some students got up and walked around the room doing their own counting. These difficulties led the teacher to discuss with the students the best way to obtain the data, which required organization of the class.

Table 3- Summary of didactic pre-sequence proposed by Buehring (2006)

Class I	Ask students their names, ask them to write them on a card. Collective decide on a color for boys and a color for girls to fill in the chart. Ask all students to put their cards on the brown paper placed on the board, but before that, discuss the best way to organize them so that they can be viewed more easily.
Class II	Ask students to register their ages in tables. Perform the same collective work of pasting data about students on brown paper and subsequently compare the data. Organize a table with the ages of boys and girls.
Class III	Recapitulate the data of the previous classes and place them onto checkered meshes, forming column graphs. Present the same data recorded on the posters with different types of graphs, previously made by the teacher-researcher. Collective discussion about the content shown in the graphs and the similarities and differences of those graphs to data collected in the previous classes by the group.
Class IV	Recall what was done in previous classes, ask some students to define what graphs and tables are. Give out magazines and newspapers and ask students to find graphs or tables on them, cut them out and paste them on a board, sorting similar graphs by type. Students recount and individually summarize what they learned in the four classes.

Fonte: Buehring (2006, p. 46 - 52)

During the activity of recording ages, the students suggested using tokens and representing each age with a different color (Figure 3), after that, they represented the results in numerical tables (Figure 3). The students also discussed how they could cross reference data regarding age and sex. This enabled the introduction of double entry tables.

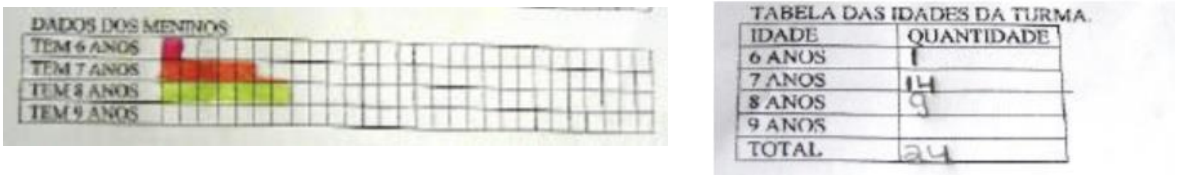

Figure 3 – Representation of the ages of male students (left) and of all students in the class (right).
Fonte: Buehring (2006, p. 51)

On the third class, the teacher presented the same data collected by the students in different graphs she had prepared (Figure 4). She asked the students to comment on the graphs in order to verify if they recognized the data collected by them in this other form of

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representation

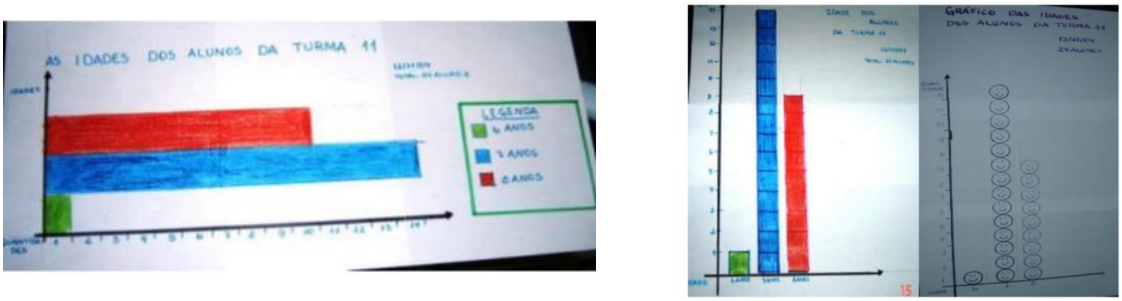

Figure 4 – Representation of the ages of students in the class
Fonte: Buehring (2006, p. 51)

On the fourth class, students were asked to express what they thought graphs and tables were. This activity created some difficulty, however, through association with the activities carried out in previous classes, they answered: "it is to know how many boys and girls are in the room, pasting papers and taking notes for us to look at and then remember" (Buehring, 2006, p. 52). After that, the students looked through newspapers and magazines for graphics and tables. They found several types of graphic representations, which were sorted into tables, bar, column, sector graphs, and even maps and pasted on brown paper.

According to Buehring (2006), transitioning from reality to representation on cards, in the first class, was the most difficult part. However, a lot of learning occurred as a result of the comparisons between the representation records used by the students, since the contents of their records were different. This comparison enabled students to realize that it is possible to make several records of the same object. For the teacher/researcher, although the activity explored data analysis in a simple manner, it made it possible to work with statistics through the investigative process in the first year of PE.

Bowling

In order to work on randomness with students of the second year of elementary school, while writing her professional masters' dissertation, accepted in 2018, Sezilia Elizabete Rodrigues Garcia Olmo de Toledo proposed a ludic activity; a bowling game. The game consisted of six pins numbered from one to six. Each student threw the ball once attempting to hit the pin. After each throwing, students recorded on a chart which pins fell. Statistics was present in this activity through the organization of results of the attempts, first of individual throws, and, subsequently of the collective results of the class (Toledo, 2018). Thus, after the game was finished and the notes were entered onto a collective table (Figure 5), the students built a column graph (Figure 5) in order to ascertain the pins that fell most frequently among all the throws made by the class.

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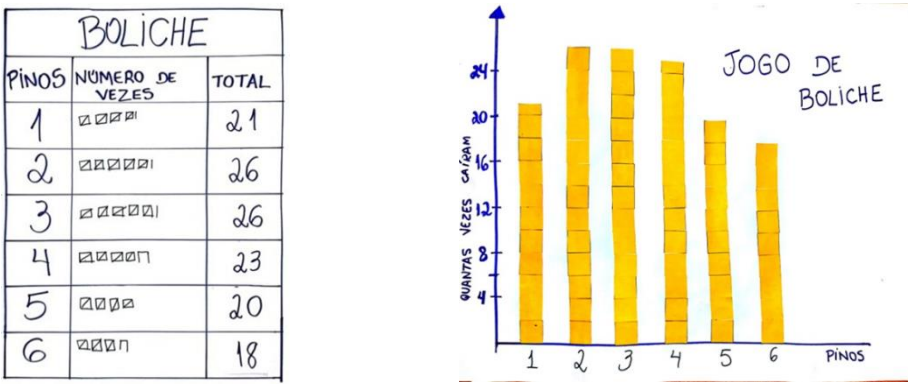

BOLICHE		
PINOS	NÚMERO DE VEZES	TOTAL
1	𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸	21
2	𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸	26
3	𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸	26
4	𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸	23
5	𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸	20
6	𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸𝍸	18

Figure 5 – Table and column graph with the records of students' collectively-made entries[9]
Font: Toledo (2018, p.92)

According to the author, during the discussion of their ideas about the result of the game, the students demonstrated that they understood the notion of randomness present in the throw and the uncertainty of the falling of pins. In his account, one of the students, named Rodrigo, commented that "we cannot see the future" (p.91). According to Toledo (2018), this expresses the student's understanding that the future is uncertain. Activities such as this help students understand that not every experiment is deterministic.

This game, in addition to exploring the probabilistic knowledge prescribed in the BNCC for the early years of ES, used playfulness to motivate students. In their accounts, children emphasized how much they enjoy fun activities which enable more active participation. Moreover, Toledo (2018) observed that the use of games as a pedagogical practice does not necessarily lead to rivalry among students "this competitive attitude was not really present during the games. The children were happy to be able to play and interact with their classmates" (p. 95). This reveals that well-planned recreational activities can, in addition to teaching school content, promote respect for oneself and the other, contributing to the development of the empathy and cooperation skills advocated in BNCC.

Horse Racing

Toledo (2018) also proposed an activity using a game with two dice called Horse Racing. The activity was aimed at exploring randomness, impossible results in the rolling of the dice, results most likely to occur, as well as the concept of possible and impossible events.

The teacher/researcher presented the class with a board, which contained a line numbered from 1 to 13 (Figure 6). Each of these 13 numbers represented a horse. During the activity, the students chose one of the horses on the board, cast the dice, calculated the sum of

[9] Boliche = Bowling, pinos= pins, número de vezes= number of times, Jogo de Boliche = bowling game.

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the upward faces and recorded the result on the corresponding column of the board.

With each throw of the dice, the horses would advance one square on the board. These results indicated the progress of that horse in the race. The game ended when one of the horses reached square number ten. “The game was exciting, the children cheered with each horse that moved [...]. The students were engaged in the game, which ensured the understanding and movement of the horses through the dice roll, without production of strategies.” (Toledo, 2018, p. 73).

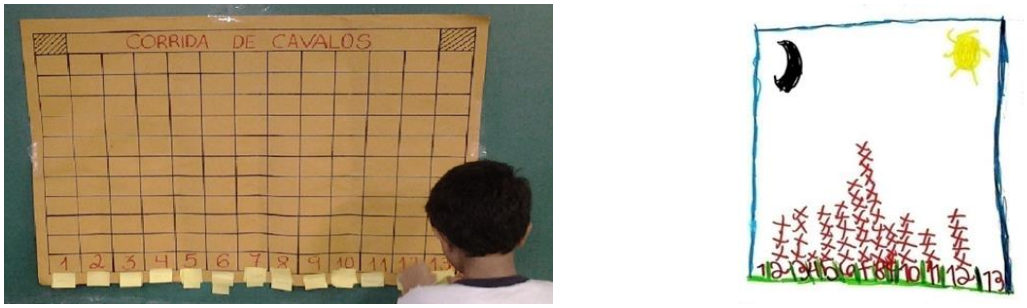

Figure 6 – Board and column graph with the entries of the results for the Horse Racing game.
Font: Toledo (2018, p.61 e 76)

After the game, the teacher/researcher discussed the results with the students by analyzing the board. The column chart elaborated by the students (Figure 6) shows that the horse that won was number 8, followed by horse number 7, thus showing that the one with the greatest chance does not always win the game. In the dialogue, the children attributed the victory of horse 8 to luck and not to the fact that it was more likely to win than other horses.

Through this dialogue the teacher/researcher realized that the students had reached the conclusion that it is impossible to get 1 or 13 by throwing two dice, that the maximum sum possible is 12, and that some sums are more likely to occur then others. Therefore, the activity made it possible to develop the skills contemplated in the BNCC, regarding probability from the 2nd to 4th year of elementary school, which are: classify the results of random daily events as unlikely, very probable, improbable and impossible; identify all possible results, estimating those that are more or less likely to occur; recognize characteristics of most likely results, without using fractions.

In this section we have shown the activities proposed. In the next section, we will highlight the potential of such activities in developing the probabilistic and statistical skills required for the initial years elementary school and their connection with the general competencies provided for in the BNCC, despite the fact that some dissertations had been written before the publication of that document.

Reading and reflection on the activities proposed in the light of BNCC

Regarding the skills listed in BNCC (*Base Nacional Comum Curricula*r - National Core

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Curriculum) for elementary school, we observed that the didactic-pedagogical proposal of Souza (2007) covers most of the key content that must be guaranteed to students at the beginning of that stage. At first, the work included collecting and organizing data from research, thus helping develop the skills required for conducting surveys and organizing data by means of personal representations. After that, the students represented the data by means of column graphs; while doing so they learned how to read data expressed in tables and single-column graphs. This way, the objects of knowledge recommended by the BNCC, for the study of statistics, in the first year of elementary school, were largely covered: collection and organization of information, personal records for communication of information collected, reading of tables and single-column graphs.

Moreover, this didactic-pedagogical proposal also states one of the specific competences in the area of mathematics, which is "to understand the relationship between concepts and procedures of different mathematical fields (arithmetic, algebra, geometry, statistics and probability) and other areas of knowledge" (MEC, 2017, p. 267), as, even though the focus of the work is on the topic of probability and statistics, the students mobilized knowledge built regarding numbers.

Besides what Santos (2007) explored in that activity, elementary school teachers can propose that students read, interpret, and conduct critical assessments and develop argumentation based on statistical information, thus promoting the students' statistical literacy. When Buehring (2006) included data interpretation in the teaching pre-sequence proposed, she showed students other forms for representing data and encouraged them to look for graphs and tables in newspapers and magazines. In our daily lives, graphs are present in many situations; they allow us to discuss and reflect about the meaning of information they contain. The proposed activity of researching newspapers and magazines, in which students find and classify tables and different types of graphs, enables interdisciplinary work through analysis and reflection about data, as well as stimulates the appropriation of such language to understand aspects of geography, history, social and cultural realities.

In Buehring's (2006) teaching sequence we also observed the development of the skills recommended by BNCC for the initial years of elementary school. The proposal is comprehensive and involves skills recommended for first, second and third grades. It includes introducing students to column and bar graphs, as well as pie charts and pictographs, the construction of which will be reviewed in later years. There is also an important discussion about the possibility of cross-referencing data which can lead to the notion of double-entry tables. Thus, the author, starting from simple activities whose dynamics enable students to produce and record information in an organized fashion, promotes the development of cognitive processes of reading, interpreting and comparing data displayed in tables and graphs.

In that activity, which consisted of looking for tables and graphs in magazines and newspapers, elementary school teachers can also explore interpretation, analysis and reflection

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regarding data organization. It is possible to ask students what would happen to the graph if any given condition were modified, what the differences in the graphs would be if different types of representations were used, and what conclusions can be drawn from the information organized in the tables and graphs. Reading and interpreting data are as important as knowing how to identify different forms of representation. This way, the teacher bolsters the appropriation of this type of language so that students can understand aspects of reality and their environment; this in turn helps them develop the fourth specific mathematics competence, which is defined as:

> Making systematic observations of quantitative and qualitative aspects present in social and cultural practices, in order to investigate, organize, represent and communicate relevant information, interpret and evaluate it critically and ethically, and produce convincing arguments (MEC, 2017, p. 267).

Following the trend of development of general competences in the BNCC, it is also possible to contribute with the seventh competence in relation to:

> Based on facts, discuss data and reliable information in order to formulate, negotiate and advocate common ideas, points of view and decisions that respect and promote human rights, social and environmental awareness and responsible consumption at local, regional and global levels, assuming an ethical position in relation to the care for oneself, others and the planet (MEC, 2017, p. 9).

Therefore, the two teaching proposals developed in the dissertations of Souza (2007) and Buehring (2006) comprise activities that enable the revision of some statistical concepts and ideas inherent to data analysis in the early years of elementary school as prescribed by the BNCC. We agree with Buehring (2006) that "oftentimes during their schooling and life, students will need this basic information and there is no better time to learn then during with the students' early education, incorporating it as another language to be used scientifically and heuristically" (p. 55). Moreover, we point out that the starting point of such proposals are students' context and reality, which boosts their investigative spirit and helps them exercise creativity, critical analysis and logical reasoning. This way, such proposals enhance the development of mathematical literacy which is defined as the competence and skill to reason, represent, communicate and discuss mathematically as advocated in the BNCC (MEC, 2017). More specifically, within the realm of statistical education, the activities proposed make it possible to develop statistical literacy, as they encourage students to interpret and critically evaluate statistical information in context, as well as become competent to communicate their understandings and give opinions about the conclusions drawn (Gal, 2002; Cazorla & Utsumi, 2010).

It is also noteworthy that the pedagogical proposals mentioned also favor the development and appropriation of the general competences listed in BNCC. Such competences are related to the social, affective, cognitive and emotional development of the students. Based on the students' curiosity, the teachers / researchers proposed activities in which they played the role of researchers. By using the school environment as a place for research it was possible

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to survey hypotheses, search for information and produce systematized knowledge, which contributed to the development of competence number 2: critical and creative scientific thinking. Moreover, the teaching and learning situations facilitated communication among students and other interlocutors, through the articulation of oral, written and graphic language (competence number 4: communication). They also promoted development of empathy, collaboration, respect and appreciation of the diversity inherent to human beings and society in general (competence number 9 - empathy and cooperation).

The two activities proposed by Toledo (2018) to develop the skills inherent to the knowledge of probability enabled the teacher/researcher to explore randomness, that not all experiments are deterministic, results impossible and some are most likely to occur. They also allowed the exploration of two different probabilistic approaches: empirical and classical. The empirical probability approach was present in the bowling game and in the horse race when the students recorded the results obtained. The classical approach was explored in the horse racing game when the teacher worked with all the possible results while using two dice. According to Batanero (2005), working with these two approaches gives students the opportunity to develop intuitions and different notions about probabilistic knowledge. For that author, probability has different meanings and they should be taught progressively so as not to be confined to just one perspective.

Another aspect to be considered in this discussion is the importance of creating school spaces that provide interaction, conversation and healthy coexistence. This helps students develop skills and competences and deal with the socio-emotional dimension, since it favors knowledge and personal and collective understanding of human diversity, improving self-esteem, self-confidence and emotional balance.

Furthermore, encouraging dialogue, learning how to listen and respect different points of view, also contributes to the empowerment of students and to the development of responsibility and civic awareness of the autonomous subject, who wishes and needs to build a more equitable and supportive society. We also highlight the discussion promoted by the teacher/researcher about the results of the games. This action, besides fostering probabilistic thinking, encourages the development of the students' argumentative skills, encouraging the expression of ideas and the collective debate which helps build and sustain argumentation.

The pedagogical proposals described herein fostered group work, questioning, critical thinking, and argumentation, which arose students' curiosity. We understand that such proposals are important and necessary in classroom work since, besides providing progressive development of skills, as shown here, they also enable the articulation of the work according to the general competences listed in the BNCC for primary education. Of particular interest is the development of the following competences:

> Exercising empathy, dialogue, conflict resolution and cooperation, making oneself respected, fostering respect for others and for human rights, welcoming and valuing the diversity of individuals and social groups, their knowledge, identity, cultures and potentialities without any

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type of prejudice (MEC, 2017, p.10).

The activities described in the pedagogical proposals encourage appreciation of knowledge and bolster curiosity and a dialogical stance, as well as prepare students to critically judge and apply knowledge, while respecting themselves and others, all of which contribute to human development in order to build a just, more democratic and inclusive society, according to the guiding principles which underpin the BNCC.

As Serrazina (2014), we also advocate that the formation developed as a result of classroom practices increases the confidence of mathematics, statistics and probability primary education teachers. Moreover, according to that author, in-service education promotes reflection about the teaching practice and increases teachers' mathematical/statistical, didactic and curricular knowledge. In turn, this augmented knowledge of teaching has a positive impact on the students' learning process.

Considerations

The recommendation for including probability and statistics in the early years of elementary school already existed in the PCN (*Parâmetros Curriculares Nacionais*, National Curricular Parameters). However, in classroom practice of teachers' approach still showed many gaps and weaknesses. These weaknesses have been discussed by groups of researchers and educators in statistical education, resulting in investigations and the creation of significant pedagogical strategies to support and increase the work developed at this level of education.

The research conducted by Souza (2007), Buehring (2006) and Toledo (2018) revealed possibilities and understandings that can be used with students in the early years of elementary school in order to contribute to the development of skills related to the study of probability and statistics. In addition, the results of these authors' research show that having experiences that arouse their interest helps of students remaining proactive, inquisitive and imaginative throughout the activity, as is expected of children. The experiences also favor the development of socio-emotional skills such as communication (ability to listen, understand and share information through speech), curiosity (cultivation of a mindset that always seeks to learn, understand the world and explore new ideas), resilience (ability to deal adequately with challenges and change, without giving up on one's identity or learning) and critical thinking (decision making and learning new concepts after critical analysis of information and statements with which individuals are confronted).

The pedagogical activities proposed in the dissertations selected established relationships between probabilistic and statistical content and some of the skills that must be developed during primary education according to the BNCC. This way, the activities promote students' autonomy and citizenship as recommended by the BNCC, as well as their statistical literacy.

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It is important to point out that after the BNCC, the inclusion and implementation of probability and statistics content in the early years of elementary school, renders the introduction of such concepts, and respective teaching strategies, in teacher education courses even more urgent. In addition, continuing education, focusing on statistical education, as well as the socialization of research results, such as those presented herein, will contribute for the planning and development of classes of teachers who are already working in the early years of primary education.

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