



Presentation

Statistical Education and the processes of learning and teaching Statistics and Probability

Educação Estatística e os processos de aprendizagem e ensino Estatística e Probabilidade

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The present dossier was an initiative to bring together studies and research that have been dedicated to discussions in the field of Statistical Education with the objective of disseminating texts on the processes of teaching and learning Statistics and Probability, which involves the epistemology of statistical and probabilistic concepts, the development of teaching strategies, as well as the cognitive and affective aspects involved in these processes.

In the current Brazilian scenario, we point out that the Common Curricular National Base - BNCC published in 2017 referring to Early Childhood Education and Elementary Education and in 2018 including High School, the advancement of Information Treatment expressed in the National Curriculum Parameters - PCN, stands out, which is now explained as a thematic unit named “Probability and Statistics”.

This thematic unit is responsible for addressing concepts, facts and procedures present in many problem situations in everyday life, science and technology, and all citizens need to develop skills to: collect; organize; represent; to interpret; and analyze data; in a variety of contexts, in order to make well-judged judgments and make appropriate decisions. This includes reasoning and using concepts, representations, and statistical indexes to describe, explain and predict phenomena (MEC, 2018).

Submetido em: 29/05/2020 – **Aceito em:** 29/05/2020 – **Publicado em:** 29/05/2020

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In addition, the importance of understanding the probability and statistics currently in the world is identified, justifying that individuals are surrounded by quantitative information about their world, immersed in numerous contexts through the media, therefore, understanding the probability and the statistics would be to enable the citizen to understand this information in order to assess the context in which it is inserted and to elucidate his understanding of its reality.

In this sense, this dossier presents, from different researchers in several Brazilian states and countries in Europe, North America and South America, studies aimed at teaching probability and statistics addressing teacher education (initial and continuing), evaluations with elementary and high school students through proposals for didactic situations, theoretical discussions that support this area of knowledge and research carried out in the area. These works can be characterized as follows: (1) Productions from several Brazilian states such as São Paulo, Rio de Janeiro, Minas Gerais, Rio Grande do Sul, Paraná, Bahia, Pernambuco and Goiás; (2) Papers from the experiences of Austrian, Chilean, Colombian, Spanish, Mexican and Portuguese researchers.

The first group, consisting of five papers in this editorial, focuses on statistical content in Basic Education, using elements of the ontosemiotic approach to extend the levels of semiotic complexity to statistical tables in twelve Chilean books aimed at students aged 10 to 13; and with students of basic and secondary education in Colombia, where a set of difficulties and errors predicted in the pedagogical practice was corroborated for which there was no specific theoretical support. In Brazil, 7th grade students worked in a private school in Canoas-RS; analyzed the performance in Statistics of students from the 1st to the 9th grade of elementary school in four public schools in the interior of Bahia; and it was found questions oriented to the ninth year of Elementary Education of the School Performance Evaluation System of the State of São Paulo - Saesp.

In this context, the paper *A semiotic analysis of the object statistical table in Chilean textbooks* by Jocelyn Pallauta, María Magdalena Gea and Carmen Batanero of the University of Granada in Spain, carried out a semiotic analysis of the primary mathematical objects at work with different types of statistical tables, using elements of the ontosemiotic approach, used to extend the levels of semiotic complexity defined by Pedro Arteaga to statistical graphs for statistical tables. The distribution of these types of tables in a sample of twelve Chilean textbooks, addressed from the 5th to the 8th grade (10 to 13 years old), is also

addressed through a content analysis. The tabular representation with greater presence in these texts is the distribution table, which would be framed in a level three of semiotic complexity, subdivided into three levels, and within them the most frequent is the first, the last appearing only in the 8th grade. The contingency table, associated with the highest level of complexity, appears infrequently and, paradoxically, its use decreases with the school year.

It is described in *Taxonomy of errors and difficulties when constructing and interpreting frequency tables* in the paper prepared by Ingrith Álvarez Alfonso, Yuly Guerrero and Yessica Torres of Colombia, a qualitative research process carried out with students of basic and secondary education in Colombia. The objective was to corroborate a set of difficulties and errors foreseen in the pedagogical practice for which there was no specific theoretical support. It was established the need to focus attention on the structural elements of the frequency tables and their relationship with the errors reported for statistical graphs, in order to find a theoretical explanation of the errors associated with the tables. Data were collected from a total of 100 students, using instruments designed to obtain evidence that would allow the formulation of a taxonomy of errors and associated difficulties in the construction and interpretation of frequency tables. Taxonomy represents a theoretical contribution that can be relevant in the study of pedagogical processes related to this object of study and in the managerial design of activities to overcome or mitigate such errors and their difficulties.

In the paper *Interdisciplinarity and statistics in the data of slaves buried at Porto Alegre (1850 to 1885)* elaborated by Luciana Neves Nunes, Andreia Dalcin and Leila Inês de Mello from Rio Grande do Sul, the results of a research carried out with 7th grade students at a private school in Canoas-RS are presented, in the search for understanding demographic data of the slaves buried in the Santa Casa de Porto Alegre cemetery, in the 19th century, being able to contribute to the learning of Statistics; served for an interdisciplinary project of Mathematics, History and Sciences with a random sample of 1559 death records for slaves in the book "Africans at Santa Casa de Porto Alegre: Deaths of slaves buried in the cemetery of Santa Casa (1850-1885)", the group made graphs and tables. Through pre and posttests it was evaluated that there were advances in learning statistical concepts. Statistical concepts were mobilized in the activities and the interdisciplinary view favored the data production and analysis process, as well as fostering the debate on black slavery in Porto Alegre in the 19th century.

Statistics performance of elementary and middle school students in the context of D-Estat by Irene Maurício Cazorla, Miriam Utsumi and Eurivalda Santana from Bahia, studied the performance in Statistics of 1,305 students from 1st to 9th grade, from elementary school, from four public schools in the interior of Bahia, as part of a university-school collaborative research (D-Estat). We built three instruments, according to the level of education, of which we analyzed three questions that involve qualitative, discrete and continuous variables; conversion of data in native language to simple bar graphs; reading in single and double entry tables; calculating the mean, median and mode. The main results show that performance drops substantially from one level to another, but within each level there is a growing trend, greater in the initial years, signaling stagnation in the final years. The results indicate that it is necessary to elaborate teaching sequences validated in the reality of schools, which enable the active role of students in their learning processes and, consequently, for statistical literacy.

The research entitled *The Saesp and Statistics issues for the ninth year of Elementary Education: analysis of the use of problem solving according to the document GAISE* by Edmeire Aparecida Fontana and Ailton Paulo de Oliveira Júnior, respectively from Minas Gerais and São Paulo, aimed to verify if questions oriented to the ninth year of Elementary Education of the School Performance Evaluation System of the State of São Paulo - Saesp, address statistical content using problem solving according to the American document “Guidelines for Evaluation and Instruction in Statistical Education - GAISE”. For the selection of questions, there was a defined time frame, as they are available online in the pedagogical reports from 2008 to 2018. For the presentation and analysis of the questions have been described the type of reasoning used, issues were analyzed according to the problem solving and the variability starting from the document GAISE; and finally, suggested new questions. The results indicate that despite being expressed in Saesp's annual pedagogical reports that there is the use of problem solving in the elaboration of questions, they were not elaborated considering the theoretical principles of the GAISE document.

The second grouping consists of six papers, still focused on statistical content, but aimed at the initial and continuing education of teachers in Basic Education.

For the *Development of didactical knowledge of teachers in statistics: a teacher education experience* by Bruna Mayara Batista Rodrigues, João Pedro Mendes da Ponte from the University of Lisbon in Portugal, there is a focus on representations and statistical investigations, two aspects fundamentals of Statistical Education. The training relates to the

discipline of Statistics of a Specialization Course for teachers of Mathematics in Basic Education, with 13 participants. Data were collected during the sessions through a logbook, audio recordings, documentary collection and interviews. The discipline was structured in order to articulate didactic knowledge from activities aimed at teaching practice. The results show that teachers deepened their knowledge about statistical representations and how to teach them. In relation to statistical investigations, teachers highlight the importance of valuing these activities for the formation of critical citizens capable of handling information.

Evaluating the *Comprehension of statistical graphs and tables by primary school teachers-in-training*, Daniel Eudave Muñoz, Cecilia Macías, Margarita Carvajal, María Guadalupe Muñoz from Mexico evaluated the performance of elementary school teachers, as it is a curriculum content for elementary school and for their use in carrying out educational diagnostics and planning. Therefore, initial teacher education should consider these topics. An exploratory-descriptive investigation carried out in two phases is reported: in the first, a test was applied to analyze a graph and a statistical table for the 240 students of the Bachelor of Basic Education, in a Normal School, in Mexico; in the second, task-centered interviews were conducted with a sample of nine students, to recognize their understandings and difficulties. The results show different levels of understanding of the graph and the table, as well as the underlying fundamental statistical concepts. The results suggest that the students did not work enough with graphs and statistical tables.

Focusing on the *Understanding about graphs by field school teachers*, Josilane de Souza and Carlos Eduardo Ferreira Monteiro from Pernambuco, they interpreted statistical data presented in graphics that according to the authors are linked to skills that should be developed by citizens in the course of their schooling. In Brazil, rural education contexts are challenging since this type of demand considers the specificities of rural contexts. This paper discusses aspects of a research that investigated the understandings about graphics that school teachers in the field showed from interviews and continuing education workshops on statistical literacy. The results obtained from the interviews showed some gaps in relation to the conceptions of Rural Education, as well as evidenced difficulties regarding the understanding of the graphics proposed for interpretation. The training workshops proved to be important training spaces for statistical literacy since teachers felt encouraged to enrich their pedagogical practice.

Addressing *The Statistic on Secondary School: in pursuit of contextualization* of Alyson Fernandes de Oliveira and Dalva Eterna Gonçalves Rosa from Goiás, it was characterized by a case study, the understanding of how Statistics has been approached in the classroom in High School, in order to provide students with contextualization of content and a critical view of the contemporary world. In a qualitative approach, the data produced were obtained through observations in the research environment, interviews with teachers and focus groups with students in the 3rd grade of high school, which were systematized and interpreted according to the Content Analysis. The results obtained allow us to consider that, even though students are able to establish some relationships between Statistics and daily life, the way it has been approached, in the classroom, does not allow them to understand their concepts critically, since it does not it is worked in a contextualized way.

The paper *Teaching statistics in EYA: application of the methodology of problem solving* by Giane Correia Silva and Guataçara dos Santos Junior from Paraná, presents a proposal using the problem solving methodology for Teaching Statistics at Youth and Adult Education - YAE, aimed at high school, in a state public school in Paraná. The procedures of data collection were: the records of the observations and the productions of the students that generated empirical data and were analyzed using the methodology of the Textual Discursive Analysis - TDA. The Teaching Sequences - TS were elaborated from the problem solving methodology, contemplating statistical knowledge objects. The research results indicate, on the one hand, that the problem solving methodology can contribute to the development of students' statistical reasoning; on the other, that the formalization of concepts by the teacher proved to be relevant because together, teacher and students, they discuss the attempts to solve the proposed problem, contributing to the construction of statistical knowledge and citizen formation.

In *Statistics in high school: a potentially meaningful material for teaching the subject* of Luiz Marcelo Darroz, Cleci Teresinha Werner da Rosa and Rejane Padilha Quedi from Rio Grande do Sul is presented an investigation that sought to identify as a didactic sequence based on Significant Learning Theory can be considered a potentially significant material for the study of high school statistics. The sequence was presented to a group of high school mathematics teachers. For data collection, the logbook prepared by the researcher teacher and semi-structured interviews with the participants were used. The data analysis had three categories a priori: relation of the contents contained in the didactic sequence with the

students' previous knowledge; progressive differentiation and integrative reconciliation; and materials used and proposal structure. As a result, it was realized that the didactic sequence in question can be considered a potentially significant material for the study of the area, since it favors the relationship between students' previous knowledge and the subjects covered and makes it possible to establish connections between that knowledge.

Next, we observed three papers focused on Statistical Education where the first presents a new competence called behavioral, describing, and analyzing possible approximations between Statistical Education and transdisciplinary studies. A Systematic Literature Review (RSL) is also presented verifying the research that has resources that assist in the teaching and learning process of concepts involving the study of variability; and a final text proposing existing links between transdisciplinary elements and teaching practices related to the teaching of Statistics.

According to Celso Ribeiro Campos and Andréa Pavan Perin from São Paulo, discussing *About critical and behavioral competences in Statistics Education*, they indicate that research in this area has advanced intensely with the planning of activities aimed at the development of three competencies, literacy, reasoning and statistical thinking, which allow a more meaningful learning of the concepts of this science. The deepening of these researches allowed the identification of another competence that is also important for this universe, which is critical competence. The objective of this work was to deepen the reflection on critical competence, evidencing its evolution in research developed in the scope of Statistical Education, and to present a fourth competence, which we call behavioral competence. In our analyzes, we could observe that critical competence develops based on two aspects, the socio-political and the epistemological. Finally, based on several practical examples observed inside and outside the classroom, we show how behavioral competence was identified.

In the *Research on Variability in Statistical Education: a Systematic Review of Literature*, Fernanda Angelo Pereira, Chang Kuo Rodrigues and Fabiano dos Santos Souza from Minas Gerais and Rio de Janeiro conducted an investigation into the reasoning about variability according to the perspective of Statistical Education. Here is described the Systematic Literature Review (SLR) performed in order to verify the research that has resources that help in the process of teaching and learning concepts involving the study of variability. The sources of materials for the search for jobs were national and international journals in the area of Education and Teaching for the last 10 years (2008-2018), published in

Brazilian Portuguese, Portuguese of Portugal, Spanish and English. These journals were evaluated by the CAPES (Coordination for the Improvement of Higher Education Personnel) WebQualis system in the 2013-2016 quadrennium as A1, A2, B1, B2, B3. The SLR showed that there is little research that addresses the reasoning about variability in Basic Education, an important skill for the development of statistical literacy in the education of students.

Addressing *Transcendence and learning to learn: transdisciplinary indicators aimed at Statistical Education*, Alessandra de Abreu Corrêa and João Bernardes da Rocha Filho from Rio Grande do Sul, carried out existing articulations between the transdisciplinary elements and the teaching practices related to the teaching of Statistics in the years end of elementary school. We sought to describe and analyze the possible approximations between Statistical Education and transdisciplinary studies, understanding their potential in the practices mobilized by teachers. The analyzes emerged from the teaching concepts that were evidenced, in the episodic interview, answered by two participants graduated in Mathematics from the city of Canela, Rio Grande do Sul, Brazil. Data analysis was performed based on Textual Discursive Analysis, being a qualitative and comprehensive approach. The conclusions point out that there are links between the indicators of transdisciplinarity and the teaching practices that permeate the professional dimension and achieve a transdisciplinary attitude that can occur through transcendence and learning to learn.

Focusing on *Probability and Statistics in the Early Years of Primary Education according to the National Core Curriculum*, Suzi Samá and Rejane Conceição Silveira da Silva from Rio Grande do Sul started from the consideration that the social demand for understanding and interpreting the most varied information is part of our day by day made the inclusion of Probability and Statistics in Basic Education essential. Therefore, it was analyzed pedagogical proposals developed for the teaching of Probability and Statistics in the early years of Elementary Education in the light of the *National Core Curriculum - BNCC*. The study is of a qualitative nature and of bibliographic method, in which three master's dissertations of researchers from the Working Group on Statistical Education - GT12 - of the Brazilian Society of Mathematical Education were selected and analyzed. The results show that these proposals foster the investigative spirit and exercise students' creativity, critical analysis, and logical reasoning. In addition, they provide the progressive development of skills and make it possible to work in conjunction with the general skills of BNCC.

Finally, we present five papers that focus on teaching probability, initially showing the necessary steps to solve a probability task that make the properties and concepts appear natural in the context in which it presents itself and, next, we present tasks elaborated for a pedagogical game related to the concept of sample space according to the Anthropological Theory of the Didactic. We also look at the distribution of activities that work with Probability in different collections and in their volumes, as well as for different conceptions present in this didactic material. In addition, it presents an analysis of the knowledge of future mathematics teachers on the teaching of probability, in particular on randomness; and it discusses didactic aspects of the frequentist approach to probability through computer simulation.

In, *Contexts, Analogies, and Tasks that Expose the Purpose of the Key Concepts of Probability*, Manfred Borovcnik from Austria, the probability is considered and will remain a virtual concept. This specificity requires meta-strategies that go far beyond the instruction of mathematical details and require a sensible use of simulation. We suggest focusing teaching efforts on explicitly exposing students to the objective of the concept of probability. The objective indirectly shows the probability character of how the steps necessary to solve a task make the properties look natural in context. It cites the creation of appropriate tasks and interactive animations, designed to overcome learning obstacles. The focus is on three aspects of probability: the character of probability statements, the transparent use of probability for low-risk decisions, and informal considerations of inference in early education of probabilities. An essential teaching criterion is the extent to which it allows students more direct access to concepts at an intuitive level. For didactic animation design, the principles are characterized by the following ideas: A dynamic change compared to the initial situation is explored. As if it were watching a video, the different stages of the emergence of a relationship between the investigated concepts are observed.

At work *The pedagogical game "playing with probability" for the early years of elementary school: the sample space* of Ailton Paulo de Oliveira Júnior and Nilceia Datori Barbosa from São Paulo, aimed to analyze the tasks developed for a game pedagogical aspects related to the concept of sample space according to the Anthropological Theory of the Didactic (ATD). Taking as a reference the Common Base National Curriculum - BNCC, a Brazilian curriculum proposal with regard to the contents and skills to be worked on in the thematic unit "Statistics and Probability" for the initial years of Elementary School, they drew

questions for the game, which they are tasks based on problem situations whose objective is to favor the apprehension of probabilistic knowledge. The possibility of developing pedagogical work based on games and problem solving involving probabilistic content was shown, creating a resource that favors rethinking about strategic methods, resizing them in order to minimize the gap between the daily play activities performed by students, spontaneously, and the work triggered in the classroom.

In *Probability in Mathematics Middle School textbooks: different ideas* by Ewellen Tenorio de Lima from Pernambuco, performed an analysis of the mathematics textbook collections approved by National Book and Teaching Material Program - PNLD 2017, looked again at the distribution of the activities that work with Probability in the different collections and their volumes, as well as for the different conceptions of Probability present in this didactic material. In all, 875 activities were identified, a quantity that is not homogeneously distributed among the collections, nor, even, in their volumes. As regards the conceptions of Probability addressed, as expected, it was found that an absolute majority of problems work with classical probability (81%). The results found point to the need for major changes in the next editions of these teaching materials, in view of the prescriptions presented by the BNCC, which bring great prominence to the work with Probability in Elementary Education and, in particular, to the frequentist probability in the Years Finals.

Considering *Teacher training in Mathematics: a discussion on teaching probability*, Marta Élid Amorim, Ruy Cesar Pietropaolo and Angelica da Fontoura Garcia Silva from Sergipe and São Paulo, presented an analysis of the knowledge of future mathematics teachers on the teaching of probability, in particular on randomness. This investigation involved a formative process in which the issue of event independence was discussed based on the results pointed out by Peter Bryant and Terezinha Nunes. This process involved the participation of eleven undergraduate students in Mathematics from a campus of a public university in Sergipe. For data analysis, regarding the teacher's knowledge, categories discussed by Shulman were considered. As for the teaching of probability, this investigation was based on the studies of Ido Gal and Carmen Batanero, Miguel Contreras and Carmen Diaz. Kenneth Zeichner was used on the reflective practice of teachers. The analysis showed that future teachers broadened the knowledge base for teaching probability, especially in relation to the recognition of the need to overcome positive and negative conduct to understand the independence of events. In addition, they reconsidered the opposite position,

shown initially, to their teaching from the early years. Thus, the importance of training actions is highlighted to provide participants with the experience of learning situations that involve concepts of probability, through experiments and reflections.

Finally, in the paper *Computational Simulation: Aspects of Frequentist Probability Teaching*, Auriluci de Carvalho Figueiredo and Cileda de Queiroz and Silva Coutinho from São Paulo, discussed didactic aspects of the frequentist approach to probability through computer simulation. To do so, they used an applet that simulates the franc-carreau game. The data for discussion were collected in a workshop for teachers. The theoretical framework included Brousseau's theory of didactic situations and Ido Gal's model of probabilistic literacy, adopting assumptions based on second generation didactic engineering as a research methodology, since the objective was related to the continuing education of teachers. In the teachers' reports on activities that worked with the frequentist approach, they observed that the manipulation of the relative frequencies accumulated in an Excel spreadsheet proved to be relatively propitious to overcome difficulties in the use of technologies, opening possibilities for expanding aspects of probabilistic literacy, with reflections and discussions about its application in basic and higher education.

The organizing team of this thematic dossier wishes a good reading and that the papers gathered here bring an effective contribution to the area, since they bring very current works from all the researchers involved, from the different Brazilian states and countries participating in this project.

Reference

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