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Analysis of EPEM articles and elaboration of problems for teaching and teaching statistics in the early years of Elementary School

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ABSTRACT
In the history of Mathematics, Statistics has not always been prominent in school curricula, but in recent decades it has been realized that it is important to work with data and this area has received more attention and prominence due to international and national movements in favor of its teaching and learning, and thus Statistics and Probability has been officially incorporated into the curricula of Mathematics in Elementary and High School.

Keywords: Mathematics Teaching, National Common Curriculum Base, Educational Development.

INTRODUCTION

In the history of Mathematics, Statistics has not always been prominent in school curricula, but in recent decades it has been realized that it is important to work with data and this area has received more attention and prominence due to international and national movements in favor of its teaching and learning, and thus Statistics and Probability has been officially incorporated into the curricula of Mathematics in Elementary and High School.

In the data-driven world, whether it's media, reports, scientific studies, magazine articles, and websites, it's essential for everyone to have some familiarity with understanding charts, graphs, and other statistical resources.

To write this article we turned to the annals of the São Paulo Meeting of Mathematics Education (EPEM) which is a meeting organized by the Brazilian Society of Mathematics Education – Regional São Paulo (SBEM-SP) and takes place every 3 years, historically it is an itinerant event that travels through the cities of the state of São Paulo. This research aims to review the articles (Scientific Communications and Experience Reports) of the Statistical Education axis published in the annals of the São Paulo Mathematics Meeting (EPEM) 2020, which was hosted at the Federal University of ABC – UFABC. And to develop an educational product that concerns exercises based on the guideline Guidelines for Assessment and Instruction in Statistics Education, GAISE II (BARGAGLIOTTI et al., 2020) and on the observations of the EPEM work, with statistical content of the early years of Elementary School according to the National Common Curricular Base - BNCC (BRASIL, 2018) with the purpose of contributing to the

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development of Statistics teaching and learning. Like the BNCC, the GAISE II guideline has as its main goal statistical literacy for all, so that when students complete their training they will be able to interpret everyday information related to Statistics.

OBJECTIVE

The main objective of this research is to discuss the importance of promoting the development of statistical literacy of students in Elementary School - Early Years. The research problem is: What are the most used approaches to teach representations of statistical data in EPEM articles? This research is of an applied nature and proposes activities according to the BNCC and the methodology of the GAISE II guideline.

METHODOLOGY

For the preparation of this article, we searched for articles from the annals of the XIV EPEM (2020) of the Statistical Education axis for reading and categorization. This research is qualitative in nature. A total of 13 articles (Scientific Communications) and 2 articles (Experience Reports) were selected. After reading these 15 articles, the following characterizations were made: mapping; level of education (Kindergarten, Elementary School, initial or final years, High School and College) and whether the study presented a proposal for a Statistics exercise. The document GAISE II - Guidelines for Assessment and Instruction in Statistics Education (ASA, 2020) consists of Guidelines Reports for Assessment and Instruction in Statistics Education.

According to GAISE II, Statistics is a methodological discipline. It does not exist for its own sake, but to offer other fields of study a coherent set of ideas and tools for dealing with data. The need for such discipline arises from the ubiquity of variability.

The GAISE II Report improved and updated the 2005 and 2007 GAISE I Report to adjust to developments in the statistical field over the past 15 years. These enhancements include an emphasis on:

- Ask questions throughout the statistical problem-solving process
- Different Data Types and Variables
- Multivariate thinking along levels A, B, and C
- Probabilistic thinking along levels A, B, and C
- The role of technology in statistics and how it develops throughout the levels
- Assessment Items That Measure Statistical Reasoning

GAISE II presents a set of recommendations for literacy at the levels of Elementary School, initial and final years and High School.

The GAISE II Report, like GAISE I, provides a framework for statistical education at three levels: A, B, and C. These three levels are based on the development of a student's statistical literacy and not on age or education. Thus, if a high school student who has had no previous experience with Statistics, they should start with A-level concepts and activities before moving on to B-level and C.

According to the GAISE II guideline, children are surrounded by data in their daily lives. There are situations in which we try to find out what is the favorite sport or what is the favorite fruit of the students. These questions are usually answered through a data collection in the classroom. It is at A-level that students need to understand that data is not just numbers, one can go beyond that. With Statistics, we can get a lot of information about the classroom, for example, through data collection. Students should learn that data is generated in relation to particular contexts or situations and can be used to answer questions about the context or situation. Provide opportunities for students to ask questions about the context, such as the classroom, and determine what data can be collected to answer those questions.

The methodological procedures of this work are bibliographic with analysis of articles published in EPEM 2020. We classified the statistical problems found into three levels A, B and C according to the structure of recommendations for the development of students' fundamental skills in statistical reasoning proposed by GAISE II.

Thus, the studies that presented proposals for exercises were selected and the content was classified into levels A, B and C according to the criteria established by the GAISE II guideline.

DEVELOPMENT

This research aims at the statistical literacy of students in the early years of Elementary School, is based on the importance of teaching Statistics from an early age, as recommended by BATANERO (2015), who defends the possibility of the child starting to learn and recognize randomness in daily life and is also based on the guidelines of the BNCC and GAISEII documents. The motivation for proposing Statistics problems for the initial years lies in the fact of the scarcity of works of this nature when compared to other thematic units of Mathematics, since Statistics for the initial years only entered the curricula from 1997 onwards with the publication of the National Curriculum Parameters. The exercises will be made available to teachers to support Statistics classes in the classroom.

According to the BNCC, Elementary Education should be committed to the development of mathematical literacy, defined as the skills and abilities to reason, represent, communicate and argue mathematically, in order to favor the establishment of conjectures, the formulation and resolution of problems in a variety of contexts, using mathematical concepts, procedures, facts and tools. It is also

mathematical literacy that ensures students recognize that mathematical knowledge is fundamental for understanding and acting in the world and perceive the intellectual game character of mathematics, as an aspect that favors the development of logical and critical reasoning, stimulates investigation and can be pleasurable (fruition). According to these BNCC considerations, the development of statistical literacy is equally necessary and is related to statistical reasoning and thinking, and Statistical Education aims to promote statistical literacy, thinking and reasoning. Thus, all these concepts are interconnected and cannot be separated, but studied together.

According to GARFIELD (2002), statistical reasoning is defined as the way people reason with statistical ideas and give meaning to statistical information. And this involves making interpretations based on data sets, data representations, or statistical summaries of data like graphs and charts. Much of statistical reasoning combines ideas about data and chance, which leads to making inferences and interpreting statistical results. It underlies the understanding of concepts and the connection of important ideas such as variation, distribution, center, dispersion, association, and sampling or the combination of ideas about data and uncertainty that lead to making inferences.

Statistical thinking can be defined as the ability to appropriately use and/or interpret statistical tools in problem solving. This involves understanding the essence of data and the possibility of making inferences, as well as recognizing and understanding the value of statistics as a willingness to think from an uncertainty perspective. (CAZORLA et al., 2017).

The GAL, 2002 model assumes that statistical literacy involves both a knowledge component composed of five cognitive elements: literacy skills, statistical knowledge, contextual knowledge, and critical issues, and also a dispositional component composed of two elements: critical stance and beliefs and attitudes.

For the teaching of Statistics, both the BNCC and the GAISE II methodology suggest levels of learning. Both follow the idea of spiral learning that starts with a foundation with simpler content and as the student learns, gradually advances to the next more complex level, widening the curricular spiral (BRUNER, 1973), which makes learning more meaningful (AUSUBEL in MOREIRA AND MASINI, 1982).

GAISE II provides recommendations to develop students' skills in statistical reasoning at three levels A, B and C and are equivalent to Elementary and High School, consonant with the skills and objectives of the BNCC from the early years to High School in a gradual way in its complexity, as it is necessary to go through learning stages for the construction of knowledge. The GAISE II guideline mentions that it does not only consider the age of the student, but rather that even adolescent and adult learners should always start at level A, and after understanding this level well, move on to the next level.

Statistical classification is a method used in data analysis to categorize or group items into different classes based on their characteristics or attributes. In general, a statistical classification is a set of discrete, exhaustive, and mutually exclusive categories that can be assigned to one or more variables used in data collection and presentation, and that describe the characteristics of a given population.

When we do statistical classification, we select the data contained in the set of all data, which can be called the universe set.

Variable is a characteristic of interest that can be measured for each element of a search and can take on different values, that is, as the name says, its values vary from element to element. Age, weight, height, eye color, marital status, test scores, type of sport, financial income are examples of variables.

The qualitative (or categorical) variable is when the possible values it assumes measure qualities (or attributes), for example, flavor of the preferred ice cream (strawberry, chocolate, pineapple) and can be classified as ordinal or nominal.

Nominal qualitative variable is when there is no ordering between the categories, such as the variable color of a ball (green, blue, red), means of transport used to get to school (car, bus, school van), class (A, B, C), in the classroom call (present or absent), type of housing (house, apartment).

Ordinal qualitative variable, when there is an ordering or hierarchy between the different categories, such as the variable level of education (Elementary, Secondary, College), academic grades (A, B, C, D),

T-shirt (small, medium, large), social class (low, medium, high), degree of agreement (strongly agree, agree, indifferent, disagree, strongly disagree), performance evaluation (excellent, very good, good, fair, poor).

On the other hand, the quantitative (or numerical) variable is a variable that has a numerical value, that is, values expressed by numbers. For example, weight, height, number of children, number of siblings. The quantitative variable can be discrete or continuous.

The discrete quantitative variable is the variable that assumes as possible values the numbers that form a finite or enumerable set, such as number of siblings (0, 1, 2, ...).

The continuous quantitative variable is one that can assume an infinite number of values within a given range of real numbers and that result from a measurement, in other words it can be measured but is not enumerable, such as the height of a person (1.53 m).

The results of this research throughout the articles analyzed from the 2020 EPEM revealed that of the 15 published studies there are 7 articles that propose exercises and of these, 3 are level A, 2 level B and 2 level C according to the classification of the GAISE II guideline. 1 on historical aspects and 1 on hypothesis testing (Higher Education). The authors of the A-level studies used pictograms and other ludic resources supported by the GAISE II methodology and others, the most used variables were the nominal

qualitative and discrete quantitative and the most used form for data representations is the ludic one by means of tables. In this way, research becomes relevant in the context of statistical literacy and the development of more activities that develop the statistical skills of the early years are important.

We noticed that in this edition of EPEM, most of the articles contemplated the A level of GAISE II, which makes sense, because there is an alignment with the BNCC and the Elementary School - Early Years and encompass more the A level of GAISE II. since they would be very difficult exercises, even if presented to high school, as they involve subjects that are also worked on at the higher level, such as simulations and hypothesis tests. In general, levels A and B have been more frequent in the EPEM work.

According to the GAISE II guideline, the goal of the statistical problem-solving process is to collect and analyze data to answer statistical inquiry questions. The investigative process involves four components, each of which involves exploring and addressing variability:

I. Formulate statistical questions;
II. Collect/consider the data;
III. Analyze the data;
IV. Interpret the results.

Suggested exercise adapted from the GAISE II document: The students of Escola Educandário Dom Pedro are interested in knowing the type of music preferred by the class, as they are planning an end-of-year party and only have the resources to hire a musical band. In this case, the statistical question will be:

- Level A: What kind of music do the students in our class like?
- Level B: What kind of music do students in classes A and B like?
- Level C: What type of music is preferred by the students of our school? Do more than 50% of the students at our school like pop music?

A few comments regarding each level of the exercise above:

- At A-level, students collected data from all students in their class. In this case, the class was considered to be the entire population. Students develop representations in the form of tables and graphs.
- At level B, students can collect data from other classes in the same year, such as classes A and B. This includes acknowledging that a class may not be representative of the preferences of all students in the same year. B-level students develop representations with double-entry tables and

graphs, can compare their class's preferences with the preferences of other classes, and come up with other statistical questions.

- At the C level, students think about generalizing findings from a sample of a few students in the school to the entire school. To generalize to all students in a school, a representative sample of the school's students is required. At level C, a simple random sample of 60 students from the school was selected to be surveyed. The results can then be generalized to the school (but not beyond it), and the discussion of Level C can focus on basic issues such as principles of generalization – i.e., statistical inference.

The interesting thing about this exercise is to revisit the previous topics, resuming concepts and from that point on moving on to new concepts and increasing the degree of complexity of the topic studied. The teacher mediates the student's learning process, while the students work in a group to build the appropriate statistical model. The important thing is to encourage students to develop investigative skills using the statistical resources available, including digital technologies. The teacher should propose approaches that emphasize statistical literacy in this teaching and learning process.

This exercise presented has interdisciplinarity with several areas of knowledge such as Portuguese language, history, social studies, arts, as it makes connections of musical preferences of the school's students. And at the same time, the topic of the statistical question should be interesting to most students in general.

FINAL THOUGHTS

Among the works analyzed in this research, the characteristic of those that ask for the construction of pictogram tables and graphs stands out, which are fun ways to learn Statistics, that is, they resort to playfulness, which is important in the initial stages of schooling, according to the BNCC.

The types of exercises that were observed help students to make a critical analysis when drawing conclusions, to have group discussions, to obtain a significant intuition, to help in decision-making, in the formation of citizenship and statistical knowledge to be developed throughout their future career.

Therefore, this research is relevant, as it proposes the importance of developing more studies and didactic materials with exercises that develop skills as well as statistical literacy from the early years of Elementary School, since the inclusion of Statistics themes in school curricula is recent and there is still a shortage of didactic materials.

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