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Interdisciplinarity and statistics in the data of slaves buried at Porto Alegre (1850 to 1885)

Interdisciplinaridade e estatística nos dados de escravos sepultados em Porto Alegre (1850-1885)

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Abstract

This paper presents results of a research of a professional master in the field of Statistical Education done with 7th grade students in a private school in Canoas-RS. The question "*Can the search for understanding demographic data of slaves buried in the cemetery of the Santa Casa de Porto Alegre, in the XIX Century, contribute to the learning of statistics?*" served for an interdisciplinary project in Mathematics, History and Science. With a random sample of 1559 slave death records from the book "Africanos na Santa Casa de Porto Alegre: Óbitos dos escravos sepultados no cemitério da Santa Casa (1850 a 1885)" the class produced charts and tables. Through pretest and posttest it was evaluated that there were advances in the learning of statistical concepts. The statistical concepts were mobilized in the activities and the interdisciplinary look favored the process of data production and analysis, as well as assisted in the debate about black slavery in Porto Alegre in the XIX Century.

Keywords: Statistical Education; Statistical Literacy; Mathematical Modeling; Interdisciplinarity; Elementary School.

Introduction

The insertion of Statistical Education in the discipline of Mathematics is something that has been gaining space in discussions, both in academia and in schools. Statistical Education makes it possible to understand data about certain phenomena and inferences about them, so that it is possible to establish connections between Mathematics and other areas of

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knowledge, favoring interdisciplinary work. Therefore, it is necessary, already in the Elementary Education, to provide activities that favor the learning of statistical concepts and the interpretation of results obtained by Descriptive Statistics.

In this context, we understand the necessity of building the statistic literacy, that, according to Lopes (2010, p.2), "requer o desenvolvimento do pensamento estatístico, o qual permite que a pessoa seja capaz de utilizar ideias estatísticas e atribuir um significado à informação estatística"[4]. The statistic literacy makes possible a suitable positioning from the person before the most varied information present in society, and the support to the construction of another areas of knowledge.

The authors Akanime e Yamamoto (2009) define Statistics as the science that studies the necessary techniques to collect, organise, present, analyse and interpret data, in order to draw information regarding a population. The Parâmetros Curriculares Nacionais[5] (PCN) (MEC, 1998) encompass these diverse topics under the heading *Tratamento da Informação*[6]. Recently, The Base Nacional Comum Curricular[7] (BNCC) (MEC, 2017) text reinforces the necessity of a Statistical Education, understood as something wider than teaching Statistic content and concepts and it points out that students at the end of Elementary School need to know how to plan and produce research reports, do and interpret descriptive statistics that potentialise discussions on aspects about sociocultural and/or ambiental phenomena; in summary, phenomena that affects life.

This present research, that resulted in the master's thesis titled "Learning statistics concepts through a study on the deaths of the slaves of Rio Grande do Sul in the century XIX: an interdisciplinary experience (1850 to 1885)", sought to problematize the Statistical Education teaching and selected as the main question: *Can the search for comprehending demographic data from the slaves buried at the Santa Casa Cemetery in Porto Alegre, in the XIX century, contribute to learning Statistics?*

For the development of the research, it was proposed an investigation scenario to study in the classroom with seventh year students in a private school in the city of Canoas-RS. According to Lopes and Carvalho (2009), the problematization of a theme can be the seed that will support an investigation work, in which students can be asked to elaborate questions and formulate explanations. This investigation scenario involves the teacher and their class, but the students are mainly responsible for the investigative process.

In the current scenario, it was prepared an interdisciplinary project, which counted on the participation of the Science and History teachers of the school, besides the researcher, who was the class' Math teacher. The sequence of didactic activities developed aimed to propose situations that would create the possibility for students to exercise statistical analysis

[4] Free translation: "requires developing the statistical thinking, which allows the person to be capable of using statistical ideas and assign a meaning to the statistic information"

[5] Free translation: "National Curriculum Parameters"

[6] Free translation: "Treatment of Information"

[7] Free translation: "Common National Curriculum Base"

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of data from the death records of slaves buried in the Santa Casa Cemetery in Porto Alegre, starting from a random sample of the population. The development of the ability to establish relationships between variables only happens if the student is able to appropriate statistical concepts and ideas, such as distribution, position measures, uncertainty, sample and population. It is understood that you learn statistics by getting involved with it. Furthermore, when faced with real data and information, in the analysis process, discussions about our past of slavery could emerge, with statistics as a mobilizer of debates about values and human rights.

Mathematical Modeling and Interdisciplinarity: some guiding principles

Statistics helps us understand different phenomena, including those related to life conditions, the environment preservation and the promotion of human rights, which are increasingly emerging in society, requiring an interdisciplinary look. Lopes and Carvalho (2009) believe that Statistical Education, in the final years of elementary school, happens through problematization, in which students seek, organize and interpret information. In this exercise of organizing and interpreting, discussions will emerge and enhance a more critical and complex reading of the world.

One of the possibilities of working with Statistical Education in mathematics classes is through mathematical modeling. As stated by Barbosa, "a Modelagem é um ambiente de aprendizagem no qual os alunos são convidados a problematizar e investigar, por meio da matemática, situações com referência na realidade"[8] (2004, p.4). Based on this same author, we believe that:

> [...] O ambiente de modelagem está associado à problematização e investigação. o primeiro refere-se ao ato de perguntas e/ou problemas enquanto que o segundo, à busca, seleção, organização e manipulação de informações e reflexão sobre elas. ambas atividades não são separadas, mas articuladas no processo de envolvimento dos alunos para abordar a atividade proposta. nela, pode-se levantar questões e realizar investigações que atingem o âmbito do conhecimento reflexivo. [9](Barbosa, 2004, p. 75)

It's understood that an investigative and reflective environment, in a practice that uses Mathematical Modeling inside the classroom, provides students with a preparation to use mathematics in different contexts, in addition to understanding the socio-cultural role that mathematics has.

As reported by Barbosa (2001), Modeling cases can be classified in three different ways, as shown in Chart 1.

Chart 1 - Barbosa's classification of modeling cases (2001) [free translation].

[8] Free translation: "Modeling is a learning environment in which students are invited to problematize and investigate, through mathematics, situations with reference to reality"

[9] Free translation: "The modeling environment is associated to problematization and research. The first refers to the act of questions and/or problems while the second refers to the search, selection, organization and manipulation of information and reflection about them. Both activities are not separate, they are articulated in the student involvement process to address the proposed activity. In it, one can raise questions and carry out researches that reach the ambit of reflective knowledge."

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Case 1	The teacher presents the description of a problem-situation, with the necessary information for its resolution and the formulated problem, leaving to the students the resolution process.
Case 2	The teacher brings to class a problem from another area of reality, leaving the students to collect the necessary information for its resolution.
Case 3	From non-mathematical themes, the students formulate and solve problems. They are also responsible for collecting information and simplifying problem-situations.

In all cases, opportunities for discussions in Mathematics classes are created with the goal of providing reflexions about the students' reality. Such reflexions can be supported, mediated or even represented by numbers, tables and graphs, so that Statistical Education is present and integrated with the modeling process, favoring an interdisciplinary work.

Lopes and Carvalho (2009) point out the importance of promoting Interdisciplinary activities, in which students at a few moments solve exercises with a provided content and, at others, research and investigate information and data. It was sought, in the elaboration of the activities proposed for this research, to use an idea, in line with Case 2, by Barbosa (2001), wherein the teacher-researcher proposed a research theme and, in the other phases, there was a work between teachers and students, in which different questions were elaborated and debated.

The idea of interdisciplinarity is also present in the PCN (MEC, 1998) as a way to develop integration of a school subject contents with other areas of knowledge, which contributes to the student's learning.

As reported by Fazenda (2011), "[...] a interdisciplinaridade é entendida como uma mudança de atitude na forma de conceber, compreender e entender o conhecimento, uma troca em que todos saem ganhando, uma vez que há uma mudança de atitude por parte dos envolvidos"[10]. In summary, interdisciplinarity aims at building a global knowledge. Lodovici and Silveira (2011) state that:

> O recurso à interdisciplinaridade se impõe, portanto, pela necessidade de um método de análise do mundo, considerando as finalidades sociais desse conhecimento. As disciplinas, isoladamente, não podem responder de forma adequada a problemáticas extremamente complexas. Há necessidade de buscar sínteses conceituais que possibilitem o enfrentamento da investigação nas fronteiras das disciplinas.11 (Lodovici e Silveira, 2011, p.296)

[10] Free translation: "[...] interdisciplinarity is understood as a change in attitude in the way of conceiving, comprehending and understanding knowledge, an exchange in which everyone wins, since there is a change in attitude on the part of those involved"

[11] Free translation: "The use of interdisciplinarity is imposed, therefore, by the need for a method of analyzing the world, considering the social purposes of this knowledge. Disciplines alone cannot adequately respond to extremely complex issues. There is a need to search for conceptual syntheses that will make it possible to confront research at the borders of disciplines."

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So that interdisciplinarity can materialize, it is necessary to separate from the fragmented view of reality. Fazenda (2011) points out that "interdisciplinaridade na educação vai além do desenvolvimento de novos saberes, pois favorece novas formas de aproximação da realidade, social e novas leituras das dimensões socioculturais das comunidades humanas"[12] (Fazenda, 2011, p.22).

In this context, according to Lopes (2010),

> A Estatística, com os seus conceitos e métodos para coletar, organizar e analisar informações diversas tem-se revelado um poderoso aliado neste desafio que é transformar a informação bruta em dados que permitem ler e compreender uma realidade. Talvez por isso, se tenha tornado uma presença constante no cotidiano de qualquer pessoa, fazendo com que haja um amplo consenso em torno da ideia segundo a qual a literacia estatística deva ser uma prioridade da sociedade moderna, ou seja, de uma cidadania com responsabilidade social.[13] (Lopes, 2010, p.1)

Therefore, the importance of Statistics for the education of the student is clear, as a knowledge that instrumentalizes them to make decisions in conditions of uncertainty, relating school content with social life facts.

As Campos et al (2013) say, when the teacher's gaze turns to teaching and learning issues in which an environment is provided wherein research and reflexion stand out as fundamental elements in the knowledge construction process, the principles of Statistical Education can be worked on. Therefore, mathematical modeling projects, in the line of *learning by doing*, can be developed.

Methodological procedures and pedagogical practice - Description and Results

To the production of data for the research, an interdisciplinary teaching project was carried out. The option for the theme of working with data about slaves buried in the Santa Casa Cemetery in Porto Alegre was the result of a dialogue with the school's History teacher, who mentioned that the Santa Casa de Porto Alegre's Historical Archive has a collection that could be a good source of data, among them, of the deaths of free and enslaved people in the 19th century. This idea also awoke the interest of the Science teacher, due to the possibility of studying the diseases associated with the deaths.

Initially, the Mathematics, History and Science teachers articulated themselves for the construction of an interdisciplinary teaching project and decided, for logistical reasons, that

[12] Free translation: "interdisciplinarity in education goes beyond the development of new knowledge, as it favors new ways of approaching the reality, social and new readings of the socio-cultural dimensions of human communities"

[13] Free translation: "Statistics, with its concepts and methods of collecting, organizing and analyzing diverse information, has been revealed to be a powerful ally in this challenge, which is to transform raw information into data that allow us to read and understand a reality. Perhaps because of this, it has become a constant presence in anyone's daily life, causing a broad consensus around the idea that statistical literacy should be a priority in modern society, that is, of a citizenship with social responsibility."

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the school's seventh year students would be invited to be part of the project. This project became the object of study for the master's research in question. Teachers considered that, for the project to be better accomplished, it would be better to include volunteer students because the research would be carried out in the evening and "accepting the invitation", according to Barbosa (2001), is essential for the student involvement environment in the mathematics research.

Nine volunteer students took part in the research with parental consent, and the Consent Form was signed. The development of pedagogic practice took place in the first semester of 2016.

Specific procedures and results developed in the area of Mathematics were carried out, with the objective to establish an environment to work with mathematical modeling in the classroom that fits in Case 2, defined by Barbosa (2001).

In order to gather tools on prior knowledge and the consolidation of the statistical concepts covered, pre-test and post-test questionnaires were used. The pre-test had seven questions, three of which were multiple choice, formed by basic statistics content. The first two questions were open and identified whether the participants were aware of the concept of population and sample. The third and fourth questions were about reading and interpreting graphs; the fifth, sixth and seventh questions were about mode, mean and median, respectively. To evaluate the consolidation of learning, a post-test was carried out containing the same questions as the pre-test, three months after the end of the pedagogical practice. In this evaluation, the percentages of correct answers in the pre-test and in the post-test were compared, based on the correction made by the teacher-researcher.

Twelve weekly meetings were held with the class, totaling 26 hours worked together. In these meetings, the school library computers and the internet were used. To complete all the proposed tasks, the participants also had hours of work without the presence of the teachers, usually in their homes, individually or even in groups. Through the use of technological resources, the group worked in different ways, including remote moments using Google support tools, such as *Google Forms, Google Drive, Google Docs* and discussions in a *WhatsApp* group created by the students.

After giving the pre-test at the first meeting, the concepts of population and sample were presented through a slide show. At this meeting, participants began to handle the book "Africanos na Santa Casa de Porto Alegre: Óbitos dos escravos sepultados no cemitério da Santa Casa (1850-1885)"[14], a work by Flores (2007) that had been proposed as an object of study by the history teacher. From this contact with the book, the class learned that the population to be studied was the slaves who were buried in the Santa Casa Cemetery, between the years 1850 and 1885. Figure 1 shows the cover of the book used and an example of how the data from the slave death records is presented in the book.

[14] Free translation: "Africans at Santa Casa de Porto Alegre: Deaths of slaves buried in the cemetery of Santa Casa (1850-1885)"

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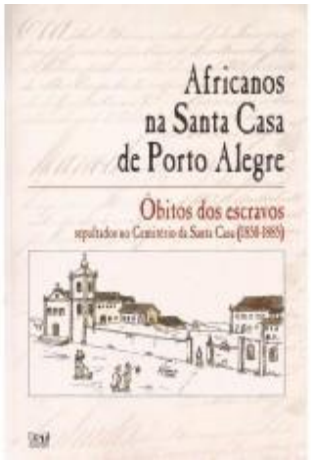

(A)

ANTONIO, pardo, 39 a., s., nat. Pernambuco, escr. herdeiros do finado José Semião d'Oliveira, †6-8-1856 de tétano traumático, enc. Pe. Thomé Luiz de Souza, ent. a 6-8-1856, sep. 1724 (Reg. 2611).

(B)

Figure 1 – (A) Cover of the Flores' book (2007); (B) Death record example as presented in the book.
Source: Book "Africanos na Santa Casa de Porto Alegre: Óbitos dos escravos sepultados no cemitério da Santa Casa (1850-1885)"

Flores' book (2007) has data on the death records of approximately 7000 slaves, who died between 1850 and 1885. From reading the book and discussing about it, the students understood that the size of the population treated was too big, so they decided to randomly select a sample. From a discussion conducted by the teacher, it was decided that the sample would consist of 25% of the data in a systematic way, that is, in a way that selected records contained in the book from beginning to end. The decision on the sample size came from the participants who observed that the book brings the records in chronological order and are arranged in columns, two columns per page. Intuitively, the class decided to use systematic sampling, as it was decided that one column every two pages would be inserted in the database. The speed of the class in establishing the sample size and the way to select it exceeded expectations. The students demonstrated understanding that the sample must be representative and random.

Then, the computational resource *Google Forms* was presented to the class as a tool to create a database, and after understanding how to use it, a database was generated with data from a random sample of 1559 cases of death. The database that would be used in the construction of graphs and tables was finalized at the fourth meeting, being that during this period some difficulties on the use of technological resources were overcome by the class, sometimes with the help of teachers, but also autonomously. The interdisciplinarity was already present in the collection of data, for example, when typing the slaves' cause of death, they searched the internet for the meaning and images associated with each unknown disease, indicating the need of interacting with the Science area.

In the fifth and sixth meetings, the History teacher addressed issues related to the trajectory and life of the slaves and the importance of good quality records. This moment was

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important, as some definitions were clarified and helped to conclude the construction of the database. For example, the students cleared up some doubts about the nationality of the slaves, which was one of the variables in the records. The teacher explained that it was called "crioulo" who was born in Brazil, and "africano", the ones who had African countries as nationality. The teacher also commented that children, up to 7 years old, at the time, were considered “innocent” and around 15 years old were considered as adults. In this meeting, the students chose the age of 60 to define the elderly, being an adult between 15 and 59 years old. In addition to that, elements such as the functions they performed and the diseases of this population were also addressed. The clarification of these ideas was important for statistical analysis, in terms of understanding historical demography. At this moment, interdisciplinarity with History proved to be fundamental for the progress of the study of the class.

For the diseases described in the *causa mortis*, the History teacher suggested that they be classified based on the work of Lycurgo Santos Filho, author of the work *História geral da medicina brasileira* (1947)[15]. He explained to the class that the study of the cause of death is one of the indications of living conditions in the context of the period studied, being a window through which we can check their possible hardships, marked or not by their clothing, crafts, punishments and eating conditions.

At this stage, the content of mode, medium and median were also addressed. The teacher-researcher made use of a slide show and made the presentation available in the virtual environment *Google Docs* with the goal of getting students to know the environment and use it to fix the studied concepts and evaluate their understanding. The group showed a lot of interest in the new environment, mainly due to the possibility of simultaneous use, and they used it extensively. Regarding the statistical concepts covered, the greatest difficulty came up with the concept and calculation of median. Figure 2 illustrates the use of the *Google Docs* virtual environment.

[15] Free translation: “General History of Brazilian Medicine”

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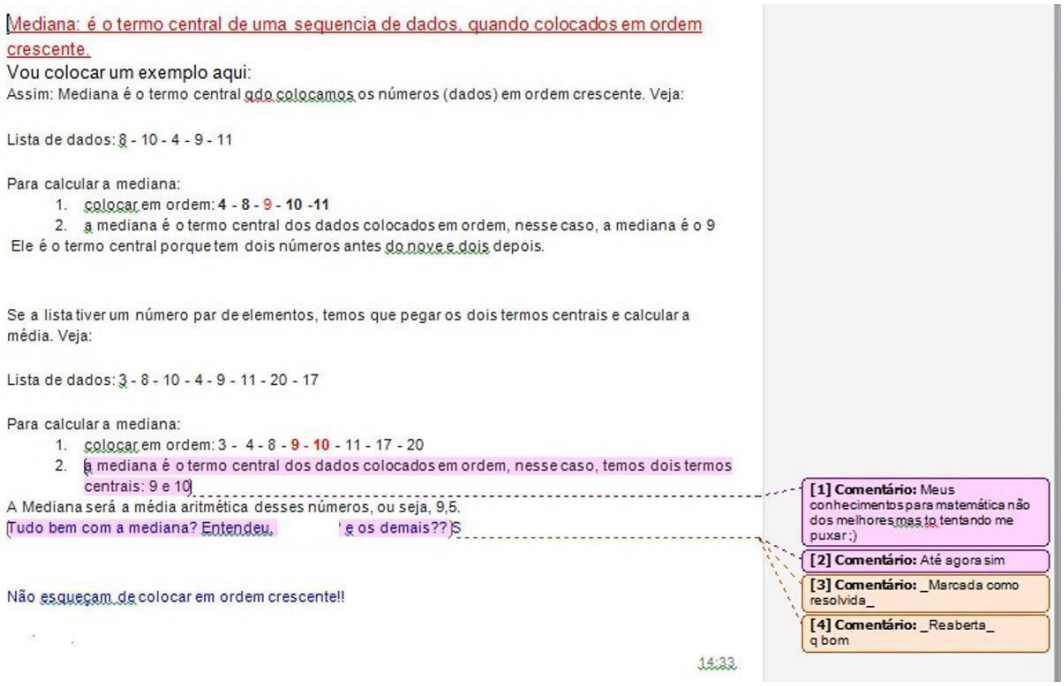

Figure 2 – Ilustration of *Google Docs* use.

Source: Authors' collection

So that the students could comprehend the origin of the data they were working with, the seventh meeting was to visit the historical cultural center Centro Histórico-Cultural Santa Casa. The Mathematics teacher, her master advisor and the History teacher went along with the class. Initially, they watched an educative lecture by a museologist about the Santa Casa de Misericórdia hospital complex, with an emphasis on its assistance character, the Santa Casa Cemetery and its Historical Archive. On this occasion, the students had the opportunity to handle the original Death Record book at the Santa Casa Cemetery that gave rise to the work of Flores (2007). Figure 3A illustrates this moment of the research.

It was very important to the students to handle the document that gave rise to the work studied in the classroom. From that visit, they became aware of the fact that, at the time of these records, the deaths of slaves were arranged separately from free people. Just as the burials were done in separate places in the cemetery. The students realized how the work of the historians who built such records was important. With each entry read, from the slaves' original death book, they remembered typing something similar. The letters, which are handwritten, received special attention, due to the way they were written, practically a drawing and not very easy to understand, as can be seen in Figure 3B.

DOI: 10.20396/zet.v28i0.8656749

(A)

(B)

Figure 3 – (A) Students handling the original book of slaves' death records at Santa Casa Cemetery; (B) Original death records book, stored at Santa Casa's Historic Archive

Fonte: Authors' collection

At the following meetings (8º to 10º), the students refined the collected data, generating the first productions from statistical analysis. In this process, *Excel* data spreadsheet software was used as a computational resource.

Figures 4 to 7 are graphs produced by the participants during the activities and are presented in this work without any changes. For this reason, some inaccuracies, such as the figure formatting or the unsuitable use of lower case letters, appear. The internal titles of the figures are authored by the students and have not undergone any changes.

The Figure 4 shows a sector chart produced by the students. This graph type choice was based on the "nationality" variable classification to be represented, which was of the qualitative type. Considering the results obtained on nationality, according to what was discussed with the History teacher, the students observed that 35% of the slaves were African, 60% were Creoles and 5% had no informed nationality. In addition to encouraging the appropriation of the statistical concept of relative frequency, in a discussion with the History teacher, this result led to the study of endogenous reproduction, which was increasingly encouraged since 1850, with the Eusébio de Queiróz Law, which banned the slave trade to Brazil. In other words, based on statistical results, the study of laws and historical facts was promoted. This moment in the research indicated the development of students' statistical literacy, with regard to reflection on statistical results and attributing a meaning to these results.

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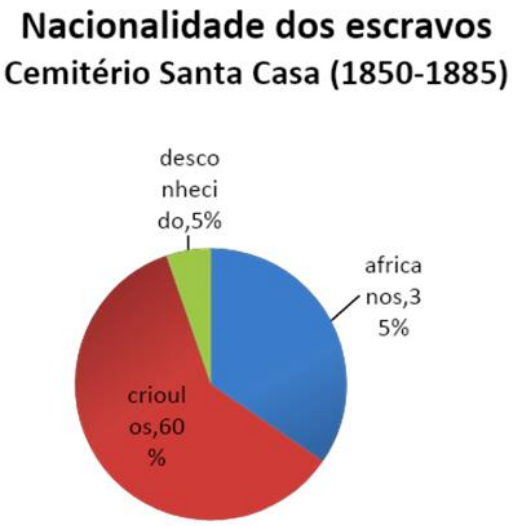

Figure 4 – Sector graph showing the variable "slaves nationality" produced by the class

Source: Authors' collection

In order to assess the relation between the variables "sex" and "age", the class decided to transform age, which was collected in years, into a categorical variable. To do this, they considered the proposal made by the History teacher, and classified as "innocent" the deaths of people up to 7 years old, "young people" from 8 to 14 years old, "adults" from 15 to 59 years old and "elderly", 60 years or more. To illustrate the relationship between these variables, the class chose to produce a multiple column graph - shown in Figure 5 -, which is indicated to visually represent the crossing of variables. The results obtained enabled a group reflection of the class involving the Science and History subjects. The graph showed an imbalance between the number of deaths of men and women. In the group of innocents, the students observed that there was a match between the number of deaths of boys and girls. However, as age advances, more deaths of men became evident in the data analyzed, which may be explained by the fact that there were more men in this population, in all age categories (young, adults and the elderly). However, the proportion of deaths of women in the "young" (41%) and "adult" (42%) categories, was higher when compared to the "elderly" category (28%). From this result, it is possible to explore with the class, in the Science discipline, certain causes of death, which occurred during childbirth or a few days after the birth of the baby, such as through the study of diseases such as tetanus and precarious forms of childbirth, which would justify registering the causes of death such as: "childbirth", "at birth", "out of time" and "seven-day illness". Again, it was possible to bring reflections of a statistical nature to the classroom, such as discussing the quality of the data that is available, in relation to historical and biological knowledge, which made it possible to analyze the results found.

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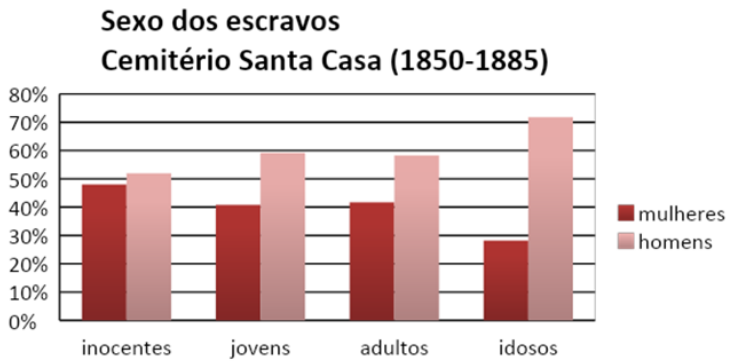

Figure 5 – Multiple column graph produced by the class to represent the relation of the variables "sex" and "age".
Source: Authors' collection.

As exploratory data analysis took place, hypotheses about the data were being elaborated. From the results observation, the students suspected, as time went by, that the pattern of the number of deaths changed and that this could be related to the age at which people died. To investigate the incidence of death according to age, based on a suggestion made by the class itself, the sample was reorganized into two groups, according to a new variable, the "age", categorized as: innocent (up to 14 years old) and adults (15 years and older than that). It was decided to show the incidences of deaths year by year through a line graph (or time series graph), as the idea was to investigate the pattern of the variable "number of deaths / year".

Figure 6 shows the graph produced by the class. They realized that there was a high "peak" of deaths in the year 1855, and this result was easily explained, using elements from the History and Science fields, since 1855 was a year of cholera epidemic. Also, through the analysis of the graph in Figure 6, students could observe that the number of deaths among slaves decreased over the years, especially among innocent people. In History classes, the graph was used to discuss the social issues that could justify this decreased number of slaves deaths over the years, and, in particular, the number of deaths of innocents after 1872 and, thus establishing a correlation between the variable pattern and the Lei do Ventre Livre (1871), which declared from that moment on that all the children of slaves were born free, causing the innocent deceased to be registered as free people. That is, from the statistical results, it was possible for the history teacher to problematize the fact that although the graph apparently indicates that the number of deaths of enslaved people was decreasing over time, this was not true. The teacher clarified that what actually changed was the document in which deaths were recorded, as people changed their *status* from slaves to free. This moment in the research illustrates how the critical thinking of statistical results can be addressed in the classroom. Although the graph that the class made is statistically correct, it does not explain what happened historically, that is, black men and women remained in precarious conditions of life even after being released and continued to die for various reasons.

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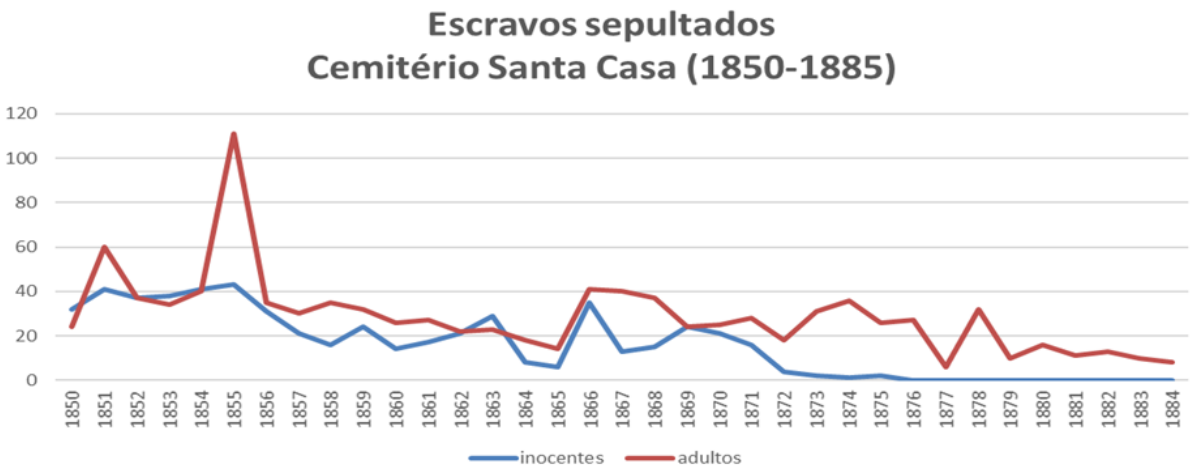

Figure 6 – Time series graph representing the pattern of the variable "number of deaths per year" according to the variable "age" produced by the class.

Source: Authors' collection.

The 11th meeting was dedicated to the study of diseases that were defined as a *cause of death.* With the participation and discussion conduction of the Science teacher, the students grouped the diseases according to the classification in the book *História geral da medicina brasileira* (1947), which classifies in 11 groups the diseases of the time studied.

The idea was to identify the diseases with the highest incidence. However, in order to organize the data, the Science teacher instructed the participants to classify the causes of death in four categories, according to the graph shown in Figure 7, produced by the class that preferred a sector graph, due to the variable being qualitative type.

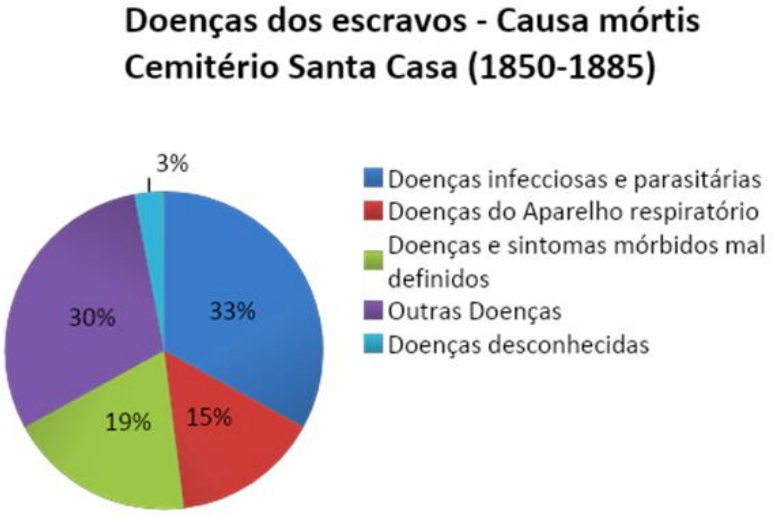

Figure 7 – Pie chart produced by the class to represent the cause of death variable.

Source: Authors' collection

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In the results observed in Figure 7, the students concluded that infectious and parasitic diseases that affected 33% of slaves stood out and respiratory diseases were responsible for 15% of deaths. However, 19% had “unknown or non-defined diseases” as their cause of death. The experience lived with the Science teacher at this meeting was relevant because, in addition to discussing how to statistically evaluate the cause of death variable, it was possible to criticize the quality of the information on the deaths described.

At the 12th and last meeting, the students prepared the *banner* for presentations in the Poster mode of some events. The students who participated in this project had the opportunity to present their work in the school's Scientific Hall in July/2016 and also in external educational events, such as the APECS-Brasil ‘I Workshop de Iniciação Científica Júnior’ in Brasília - july/2016, the UFRGS Salão Jovem in october/2016 and the III Festival de Ciência in Porto, Portugal in october/2017. In all the events in which they were present, a single banner of the class was presented, which indicated the results of the research. In the presentations, the students organized themselves so that everyone could talk about some aspect of the research. Due to financial expenses, not all students were present at all events.

Pre-test and post-test analysis

In order to evaluate how much knowledge each student obtained about statistical concepts, a pre-test and a post-test were given; the latter, three months after the end of the pedagogical practice. The idea of giving the post-test three months after the pedagogic project is because it was thought that this would be a reasonable time for students not to have the pre-test questions memorized. It was found by comparing the results of the pre-test and post-test performed, shown in Figure 8, that the Statistics knowledge of the group of students involved in the research increased, as it is possible to observe an improvement in the answers. The graph in Figure 8 shows the percentage of correct answers for each of the seven questions given in both moments.

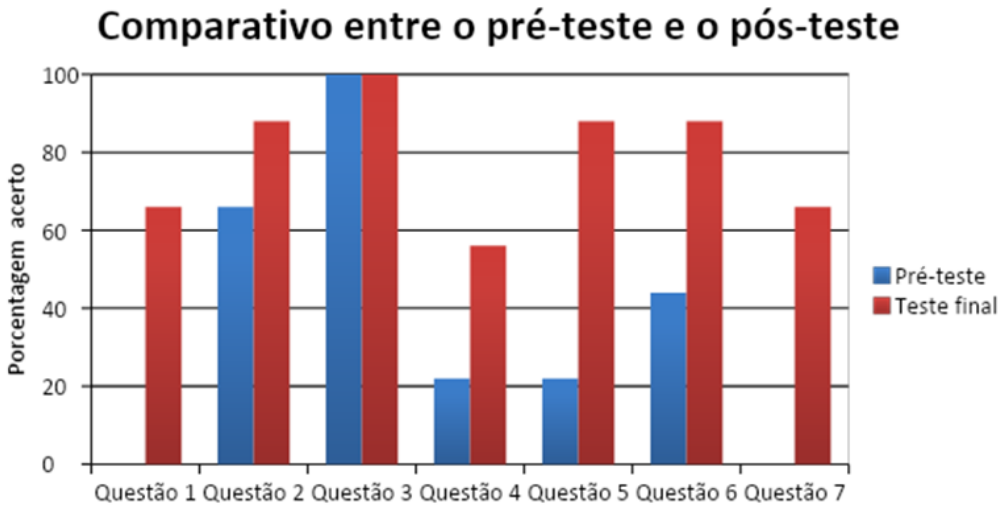

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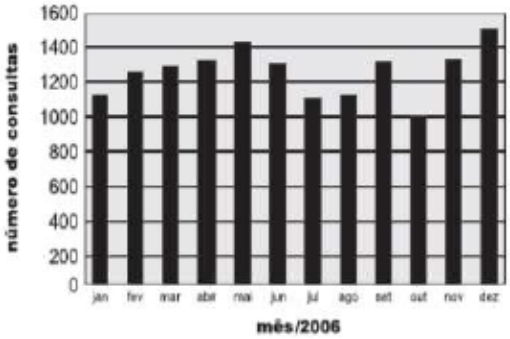
Figure 8 - Percentage of correct answers in each of the seven questions in the questionnaire given in the pre-test and post-test.

The first question "What does *population* mean? Write a sentence using the word *population*" made it clear that the group of students had the knowledge of population in geographic terms, that is, they understood population as "the total inhabitants of a region or country". Since everyone got the answer to this question wrong in the pre-test, it was concluded that they did not know the definition of population in Statistics. In the post-test, 66% of the group got the question right, which indicates that they managed to expand the concept to other examples that were different than population and number of people in a location.

The second question was "What does *sample* mean? Write a sentence using the word *sample*.". In the pre-test, it was possible to observe that the students had an idea about the sample concept, because 66% of the group got the question right. However, it is worth mentioning that among those who got the concept of sample right, 45% of the students used the word *population* in their definitions, and in 95% of the right answers the idea of "part of a whole" appeared. It is noticeable that the question of representativeness was not addressed by the majority of the group, appearing in only 22% of the responses. For the post-test, the percentage of correct answers rose to 88%.

Chart 2- Questions 3 and 4 from pre and post-tests

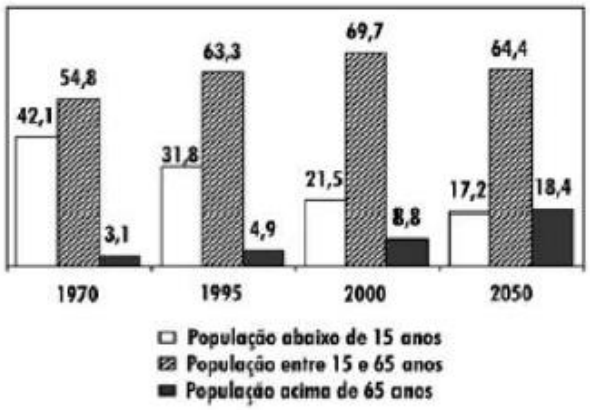
3) (OBMEP 2007) O número de consultas mensais realizadas em 2006 por um posto de saúde está representado no gráfico abaixo. Em quantos meses foram realizadas mais de 1200 consultas?



a) 5 b) 6 c) 7 d) 8 e) 9

DOI: 10.20396/zet.v28i0.8656749

4) (ENEM 2002) Em reportagem sobre crescimento da população brasileira, uma revista de divulgação científica publicou tabela com a participação relativa de grupos etários na população brasileira, no período de 1970 a 2050 (projeção), em três faixas de idade: abaixo de 15 anos; entre 15 e 65 anos; e acima de 65 anos.



Admitindo-se que o título da reportagem se refira ao grupo etário cuja população cresceu sempre, ao longo do período registrado, um título adequado poderia ser:

a) "O Brasil de fraldas"

b) "Brasil: ainda um país de adolescentes"

c) "O Brasil chega à idade adulta"

d) "O Brasil troca a escola pela fábrica"

e) "O Brasil de cabelos brancos"

The third question, presented in Chart 2, had as main objective to identify if the participants were able, based on the analysis of the information presented in a bar chart, to interpret and answer questions related to it. To assess this ability, a question that was part of the evaluation of the Olimpíada Brasileira de Matemática das Escolas Públicas[16], in 2007, was chosen. Everyone got this question right, both in the pre-test and in the post-test.

A question of low correct answers rate in the pre-test was question 4, which also aimed to evaluate the ability to interpret graphs (see Chart 2). A question from the 2002 Exame Nacional do Ensino Médio[17] (ENEM) was used, which involved a multiple column chart. In the pre-test, 22% of the students got it right, however the group showed an improvement in the interpretation of the question, since 55% got it right in the post-test.

Questions 5, 6 and 7 evaluated concepts of mode, mean and median, and the class performance was low in the pre-test, with the percentage of correct answers being 22%, 44% and 0%, respectively. In question 5, which was about mode, "*What does* mode *mean in statistics? Write a sentence using the word* mode.", the group related the concept as being the highest frequency, with examples relevant to mode in statistics. All participants correctly

[16] Free translation: "Public Schools' Brazilian Mathematics Olympiad"

[17] Free translation: "National High School Test"

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developed the calculations of the arithmetic mean in question 6 (see Chart 3), however there was an error in interpreting the data from the table presented, which generated an error in the sum of the data. On the last question, which was about the median, the students showed not to know anything about this concept in the pre-test. It was possible to verify that there was an increase in the percentage of correct answers when evaluating the performance in these questions in the post-test in relation to the pre-test. The percentage of correct answers rose to 88% in questions 5 and 6. In the last question of the test, question 7 (see Chart 3), which was about median, no one answered the question correctly in the pre-test, which demonstrated a lack of knowledge on the subject. It was evident that they did not know what the median was, since no one wrote about the median, but they commented on the variability of ages, avoiding the theme or referring to the average age. In the post-test, all of them answered demonstrating their understanding of median as the central term of a list of data. However, 66% of the class got the median right. The others made the same mistake that was considering the median value as the central value, but without considering that the list of data should be put in order.

Chart 3- Questions 6 and 7 from pre and post-tests

6) (FUNCAB - 2013 - PM-ES) A tabela abaixo representa os dados dos balanços das operações do Batalhão de Polícia de Trânsito (BPTran) da Polícia Militar – ES em três grandes feriados nacionais do ano de 2012.

Feriados	Nº total de acidentes	Nº total de mortos	Nº total de feridos
Dia do Trabalho	220	2	78
Dia de Finados	186	2	54
Proclamação da República	219	1	51

(Fonte: <http://www.pm.es.gov.br/bptran/>)

O valor que melhor representa a média do número de feridos, de acordo com a tabela acima, é:

A) 57 B) 59 C) 61 D) 63 E) 65

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7) Em uma escola, foram registradas as idades de um grupo de alunos do 9° ano de acordo com o sexo. A partir dos valores obtidos, formaram-se as seguintes tabelas:

Meninas	15	13	14	16	14	15	15

Meninos	14	16	14	15	15	13	15	14	14

A mediana das idades das meninas e dos meninos é a mesma? Explique a sua resposta.

It should be noted that throughout the practice, the concepts of mode, mean and median were worked on, however the results were not explained in this article. There were activities proposed in *Google Docs*, such as answering a *quiz* that involved questions about these concepts. And, throughout the statistical analysis of the death data, questions such as "*What is the age mode among the deaths of 1955? And the median?* " or "*Calculate the arithmetic mean of the age of slaves who died due to cholera*" were proposed

Final considerations

Throughout the research, alternatives to work on statistical concepts in Elementary Education were sought. It was tried to show the importance of Statistical Education, as well as its articulation in an interdisciplinary study, using Statistics as a communication tool between different areas of knowledge.

At the first moment, when the study proposal was announced to the students, it's possible to observe an acceptance of the invitation made by the teacher. Although the positive response to the acceptance was small in the class, as only nine students accepted the proposal, this acceptance, according to Barbosa (2001), is essential for the student involvement in the mathematical investigation environment to occur. The small number of participants may be a limitation of this study, but this was because it was an activity developed during the evening. However, it is worth mentioning that this same fact favored very rich and intense debates within the group, in which everyone actively participated.

The approach by Mathematical Modeling provided students with the opportunity to experience classes that favored the involvement and collaboration of all participants, in carrying out an investigative work that brought school Mathematics closer to the components of History and Science. Throughout the activities, it was possible to perceive the applicability of statistical concepts from an interdisciplinary context.

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In the quest to understand demographic data of slaves buried in the cemetery of Santa Casa de Porto Alegre, in the 19th century, the students experienced the selection of a random sample, the construction of the database and the elaboration of the appropriate frequency distributions and graphs, considering the characteristics of the study variables and, finally, they made the analysis of the statistical results produced, which synthesized the main subjects addressed by the disciplines of History and Science. The interdisciplinarity and the basis of Mathematical Modeling made it possible for students' statistical learning to be developed and the discussions that took place throughout the time showed that this type of teaching favored the understanding of the statistical concepts covered, as seen in the comparison of the results on the pre-test and post-test. The search for knowledge of the *cause of death* of slaves buried in the Santa Casa Cemetery in Porto Alegre, in the 19th century, gave students the opportunity to learn about the precarious conditions that slaves lived in, in the whole population: they lived in low, poorly ventilated, small and crowded places. This research allowed teachers from different areas to bring to the classroom important social issues such as discrimination and racism, which are still present today, and has generated some debates among students, making it possible to realize that, throughout the journey in conducting this study, they were able to develop a critical view from the data analysis. This critical thinking appeared in the works that were presented at the different events they participated.

It is also noteworthy the use of technologies, such as the use of *Google Forms*, slide presentations, *Google Docs* and the use of electronic spreadsheets, which helped in all stages of the pedagogical practice, whether in the creation of the database, in the exhibition content, in the construction of graphs or even in the preparation of the reports and presentations.

Studying statistical concepts operating with historical data, in an interdisciplinary perspective, showed an excellent opportunity for an experience with Statistical Education, that is, more than teaching Statistics it was possible to contribute to the formation of an awareness about the past, necessary for the formation of critical citizens who will be able to use the knowledge acquired to fight in the present for a better future, with less discrimination and prejudice.

Finally, we evidenced with this research that the study of Statistics, in fact, became the link among disciplines, boosting interdisciplinary work. Hereupon, we will continue to investigate in new researches the potential of Statistics in interdisciplinary pedagogical practices.

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