Technology Adoption for Statistics Teaching: An Approach to Enhance Learning Lessons Learned from Building an Investigative Environment

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Abstract: Active learning is one of Brazil's goals for education, and it encourages and develops students new skills and competencies for a more complete and meaningful education. The didactic sequence that we carried out promoted the articulation of statistical knowledge with the use of techniques of data collection and systematic analysis through a technological device. According to the itinerary proposed by this study, the students built the research in groups, collected the data with Google Forms among their peers, using their smartphones, and then analyzed the data obtained using an Applet developed in Geogebra. Thus, in this paper, when we present the activity, its elaboration process, its execution, and its results, we aim to collaborate with teachers and future teachers who want to adopt technology in their classrooms, especially if they want to build empirical research.

1 INTRODUCTION

The publication Brasil (2018) of the Brazilian Common National Curriculum Base (BNCC) placed Statistics as the guiding axis within Mathematics Teaching, listing, for all years, subjects of Statistics to be taught by teachers of Mathematics.

The general objective of this work is to evaluate the impact of the adoption of technology, as a way to encourage the protagonism of students to work with Statistics. This type of approach provides teachers in activity or training with an example on the use of technological resources for the development of didactic proposals based on active learning for the classroom.

This work aims to present math teachers with possible means to create an investigative environment for their students, through technology, in order to develop specific skills present in the BNCC. In particular, statistical concepts present in the BNCC provide the opportunity for systematic work with data, which is crucial in our days.

The specific objectives are: (1) To execute the work in classroom in conformity with the BNCC proposal. (2) to demystify the use of these resources as practical teaching toolsaids for everyday school life; (3) to present and discuss the construction of proposals for meaningful teaching of statistics; (4) to present and discuss proposals for the use of technology for active learning; (5) to discuss bullying inside school.

Reflecting the influences and transformations through which the processes of acquisition and representation of knowledge pass in the face of the growing volume of stored data and the evolution of technological tools to give access to this amount of

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information, the elementary instrumentation of students so that they can participate in this world, is not only instigating, but essential. This proposal aims to demystify, for teachers already working and for those in training, not only the teaching of statistics in the final years of elementary school but also the technological support that is available to students to effectively appropriate this knowledge.

We believe that teaching and learning processes should be presented to students in a collaborative and investigative way and, for this, the teacher needs to break with prerogatives acquired throughout their development process, as stated by Moraes (1996, p. 59):

> "the great majority of teachers still privilege the old way they were taught, reinforcing the old teaching, moving the learner away from the process of knowledge construction".

In this sense, we point out that by using technology for teaching, especially through dynamic software, we create a channel of communication with our student, whose use increases the student's engagement and interest, as Romero assures:

> "Technology, specifically educational software, provides opportunities for motivation and appropriation of the content studied in the classroom, since in many public and private schools, teachers use didactic resources such as blackboard and chalk to teach their classes, this is one of the many problems that cause the growth of unsatisfactory quality of teaching, especially in the state network" (Romero, 2006, Apud Cavalcante, 2010, p. 3).

Corroborating the study above, the document Reflections on the contents of probability and statistics at school in Brazil, published on the website of the Brazilian Statistics Association (ABE, 2016, p. 1) suggests that the student should be involved with the entire process, from the choice of research topic, data collection, to interpretation and discussion of results, providing an investigative environment.

Among the skills present in the BNCC, we address the concept of probability, which we can see in Brazil (2018, p. 315):

> "Calculate the probability of events, based on the construction of the sample space, using the multiplicative principle, and recognize that the sum of the probabilities of all elements of the sample space is equal to 1".

Still in this perspective, we worked on basic concepts of Statistics present in the BNCC in Brazil (2018, p. 315):

> "To obtain the values of central tendency measures of a statistical survey (average, mode and median) with the understanding of its meanings and relate them to the dispersion of data indicated by the amplitude".

In this way, we chose to work these concepts using technology and built our applet. It is possible to build very interesting didactic sequences using the Geogebra materials, available in the software platform that are made available for free by teachers from all over the world for teachers who wish to use technology in their classroom.

2 METHODOLOGY

To answer the research question we proposed a set of activities to be done with the students. The proposed activities were structured in 4 stages:

1. Question preparation
2. Peer Interviews
3. Data Analysis
4. Results discussion

This experiment was developed in an eighth grade class at the Dulce Trindade Braga school, of the network of the municipality of Duque de Caxias within the state of Rio de Janeiro and aimed to provide students with an environment for investigating the concepts of statistics in which the data collection was also idealized and performed by the students.

At school, the experiment allows students to engage with the content being addressed by the teacher, formulate their hypotheses, research solutions, analyze results, as well as actively participate with their peers in the teaching-learning process (Almeida & Malheiro, 2019).

According to Dias & Silva (2010, p. 49) we have that: "in the experiment, the researcher elaborates the research scenario, defines the variables and the subjects to be analyzed, which are divided into experimental and control".

This experiment was carried out without the control group for ethical reasons so that we did not include any students in this process.

3 BUILDING AN INVESTIGATIVE ENVIRONMENT IN CLASSROOM

The goal is to prepare students to use technological tools to produce their own surveys, and also, to practice the statistical concepts listed in BNCC

3.1 Stage 1: Question Preparation

The statistics concepts selected for this research were the measures of central tendency and dispersion; the investigated variables were classified as quantitative variables.

The students who volunteered used the teacher's computer to build the form and used their smartphones in two stages, namely: data collection and analysis.

We divided the 35 students from class 801 into 7 groups with 5 students. They had the task of elaborating a question to compose the research that we would carry out to the students of the same shift with the theme: School bullying. The theme was chosen to compose a series of projects of the school because of a meeting held by the institution's college.

It was up to the teacher to welcome the questions proposed by the groups, to make an initial filter so that no question would cause embarrassment to the respondents. After this treatment, we forwarded them to the pedagogical coordination for a second filter with the same objective and the questions returned without any change.

Each group had the opportunity to expose their question and we listed volunteers for the elaboration of the form in Google Docs so that, in the next stage, the students could interview their peers. The teacher took advantage of the opportunity and consulted the school management on questions they would like to include (questions 4, 5 and 6 were intended for the management to understand how the school unit works).

The selected questions were: 1) What is your class? 2) What is your age (in years)? 3) How many siblings do you have? 4) What is your level of satisfaction with the teachers? 5) What is your level of satisfaction with the snack? 6) What is your level of satisfaction with school cleanliness? 7) Have you ever suffered any type of bullying? 8) Have you ever suffered any type of physical or verbal aggression? 9) Have you or anyone in your family ever suffered racism? 10) Do you know anyone who has suffered sexual abuse? 11) Do you have a good relationship with your family?

This form containing the questions elaborated by the students and the direction is available at the address: https://forms.gle/ZDm9n5tND6EJKmNv6

3.2 Stage 2: Peer Interviews

Before this step, the school management and teachers of other classes were informed of the activity that would be developed.

A commission formed by one student from each group used smartphones to interview the other students and, in order for this activity to be developed, the teacher made his/her internet available and shared the form link with the group that carried out the research.

The teacher was responsible for importing the data into the Geogebra software and building the Applet for data analysis (activities present in Minicurso).

3.2 Stage 3: Data Analysis

We made available to the class the Applet (https://ggbm.at/WXadJuGs) and distributed an investigative activity (Figure 1) that needed to be manipulated in Geogebra to be able to answer the questions (appendix I) in the time made available for two lesson times, that is, 100 minutes.

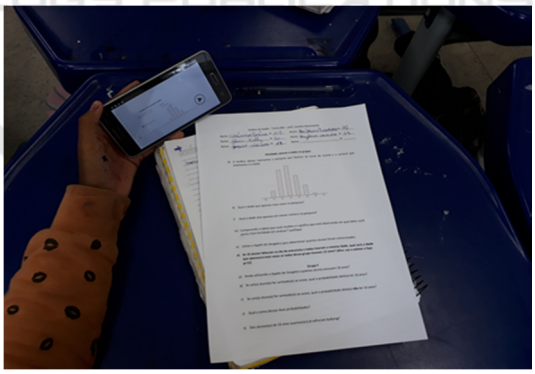

Figure 1: Investigative activity.

In the Geogebra Applet (Figure 02), by clicking on the Data Analysis button, the student could manipulate logical operators to obtain the quantities of students with specific ages. In the situation presented below, we clicked on the symbol of greater or equal (≥), we typed the value 11, we clicked on the enter button and we got the answer that 137 people answered the form.

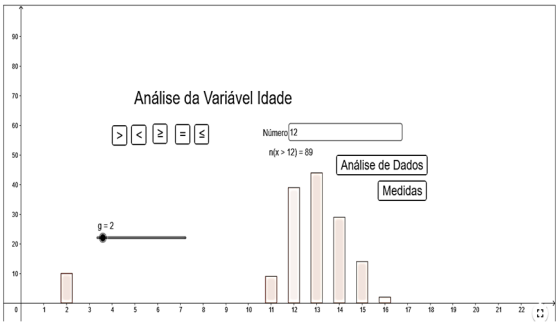

Figure 2: Initial screen of Applet in Geogebra.

By clicking on the measures button, we had the possibility to explore several scenarios in which the concepts of mean, median, mode and standard deviation could be verified with the inclusion of a supposed group of absent students, controlled by a slider control (g).

By clicking on the *measurements* button (Figure 3), we had the possibility to explore several scenarios in which the concepts of mean, median, mode and standard deviation could be verified with the inclusion of a supposed group of absent students controlled by a slider (g).

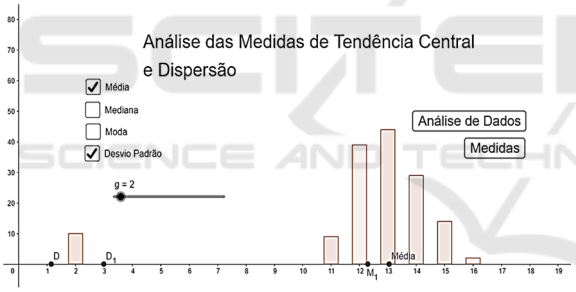

Figure 3: Applet in Geogebra within Measurements.

3.3 Stage 4: Results Discussion

At this stage, we selected the graphs generated by the qualitative variables (Graph 1) in order to discuss them in a great debate, giving everyone the opportunity to talk about the presence of *bullying* and its practice in the school environment.

On the occasion, we made use of the numbers of the research that they elaborated to raise awareness and debate, above all to point out how harmful are the jokes that point out defects and characteristics of colleagues. We suggested a collective effort to diminish this index of 42,1% observed on graphic 1.

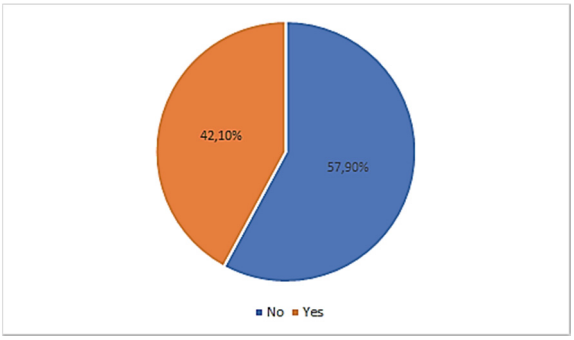

Figure 4: Graph 1: Percentage of students who have already been bullied.

4 FINAL CONSIDERATIONS

The proposed questions aimed to promote the Applet use by the group of students in order to generate effective learning of basic statistical concepts. We realized that the students remained engaged in the activities throughout the process, because in all activities they were in contact with technology and saw how it could help them to enhance their studies.

Our choice for *Google Docs* and *Geogebra* was in the direction of providing an investigative environment that could accelerate the process of data collection and interpretation, which was evidenced by Piccolli, who says:

> "the choice of software must be based on the school's pedagogical proposal of mathematics, the teacher must choose a suitable type of software to enable the student to build his/her knowledge, without leaving aside the deep domain that he/she needs to have both of the content covered and the program that he/she will use" (Cláudio & Cunha 2001, apud Piccoli, 2006, 45 - 46).

At the end of the activity, we consulted the students about the work done, especially about the technology adoption. From a total of 35 students, 23 responded to this consultation. The survey was conducted via *Google Forms* and sent to the *WhatsApp* group of the class.

In the first question, we wanted to know if the students liked to carry out the project using technology (Graph 2) and 100% of the students said they liked it.

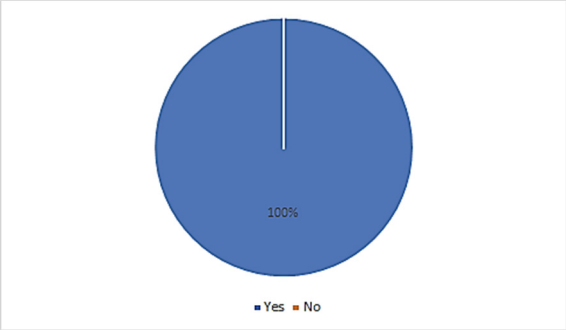

Figure 5: Graph 2: Students' opinion on the project.

Students were asked how they prefer to study mathematics (Graph 3) and 60.9% chose the option that pointed to solving problems in real contexts.

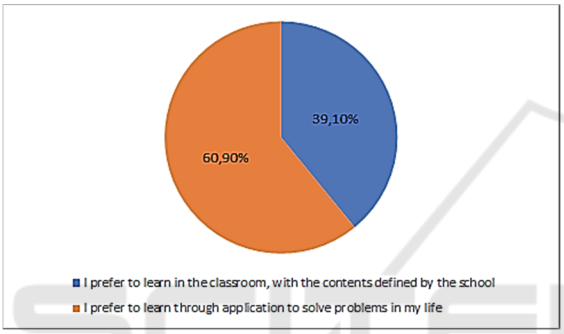

Figure 6: Graph 3: How students prefer to study mathematics.

We asked the students to make a self-assessment about the learning of statistical concepts and 91.3% responded that the project improved the way of learning.

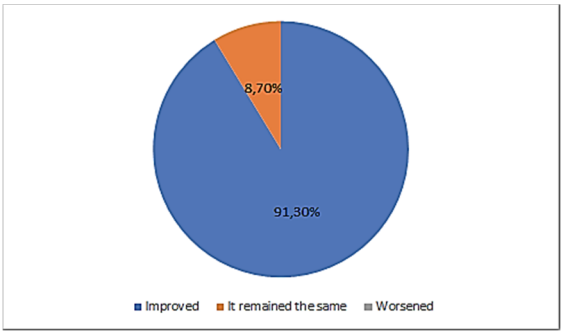

Figure 7: Graph 4: Self-assessment.

Lastly, with the data from the self-assessment and with the assessment prepared, we found that the experience seems to have improved school performance, since when we evaluated the students in the first activity (Appendix I), they had 72.67% of performance; and in the second activity (Appendix I), they had 74.67% of performance. New research with larger samples may validate the effectiveness of the learning approach used.

As a suggestion for further work, we will continue the approach in social contexts and the use of mathematical concepts to interpret the phenomena involved. In addition, we believe that research can break through school walls and reach the community more effectively, acting in forming future citizens.

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APPENDIX

Data Analysis - Class 801 - prof. Leandro Nascimento
Group components:

_____

Activity I

a) Assemble the table with all the interviewed students.

Ages	Absolute frequency	Xi fi	Fic
11			
12			
13			
14			
15			
16			

b) What is the age mode?
c) What is the median age? (melhorar o formato do apêndice)
d) What is the mean age?
e) What is the probability of randomly choosing a student and they are older than the *mean* age of those surveyed?
f) What is the probability of randomly choosing a student and they have the *mode* of the age of those researched?
g) What is the probability of randomly choosing a student and they are younger than the *median* age of those surveyed?

Activity II - Click on the measurements button of the application.

h) Activate the *mean* option and toggle the selector (represents 10 more students of an age that depends on the value of g). Has the mean changed? Justify your answer.
i) Activate the *median* option and toggle the selector (represents 10 more students of an age that depends on the value of g). Has the mean changed? Justify your answer.
j) Activate the *mode* option and toggle the selector (represents 10 more students of an age that depends on the value of g). Has the mean changed? Justify your answer.
k) Activate the *standard deviation* and mean options and toggle the selector (represents 10 more students of an age that depends on the value of g). What happens to the standard deviation when the value of g is far from the mean?Justify your answer.