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Statistics Education - Teacher Training in Investigative Classes

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***Abstract*—** *This article is an experience report. The theoretical referential involves assumptions of Zeichner's (1993) and Imbernón's (2004) continuing education, Schön's (1983) concepts of reflection and Shulman's professional knowledge, besides Ball, Phelps and Thames (2008) regarding the necessary knowledge for teaching in mathematics. The research, using a qualitative Design Research methodology, according to Cobb et al (2003), examines the contributions of a training to teacher professional development. The training was undertaken by us and focused on the teaching of probabilities through investigative lessons. The methodological procedures of data collection during the training, were by observations data production occurred from the interaction with the participants through the Classroom (https://meet.google.com), where we built graphs (histogram and the normal curve) in Excel spreadsheet, from the results of the sample space coming from wttps://www.dados-online.pt/. The collected data were analyzed by the content analysis method, according to Bardin (1979), considering the steps: pre-analysis, material exploration and treatment of results. Under the view of teaching by investigative activities, mathematics teachers participating in the formative process, reflected collectively on this methodology and discussed taking investigatively the concepts of sample space, randomness, probability definition, frequency distribution and Law of Large Numbers. This activity was entitled "PLAYING WITH THREE DATES".*

I. INTRODUCTION

Teaching statistics through games, in a dynamic way, should be seen as a potential methodology, since students in basic education tend to disperse very easily, thus, games and play can help in this process, being initially attracted by the ludic activities.

The use of educational resources in teaching, if well used, emerges as an important tool in breaking the traditional model, since according to the National Curriculum Parameters (PCN), such resources serve to enrich the educational environment, providing an active, critical and creative construction of knowledge by students and teachers. (BRASIL, 1998).

In this perspective, this research is configured as an investigation in Mathematics Education, particularly on aspects related to the use of games in the processes of teaching and learning statistics in Basic Education.

We understand that the action of investigating means to understand and seek solutions to the proposed problems and thus seek relationships, always trying to justify them.

We chose to work by means of teaching through investigative lessons, because we understand that it

enables the construction of concepts and knowledge to the learner, in order to lead him to, presume, experiment, prove, evaluate and present the results found.

For Fiorentini and Lorenzato (2006) the investigative lessons are those that mobilize and trigger, in classroom, tasks and open, exploratory and non-directive activities of the student's thought and that present multiple possibilities of alternative treatment and meaning.

Bona and Souza, (2015) highlight that the use of investigative class in teaching generates a so-called imbalance that is necessary to instigate the reasoning of the student, this imbalance occurs when the student is removed from the passivity of the classic classroom classes and becomes part of the action on the environment, on the objects, on the ideas with colleagues, and also experimentation, creation and solution of problems, observations, tests and research.

This paper seeks to highlight the importance of the participation of 20 mathematics teachers in a training course regarding their perceptions about their preparation to teach statistics in their classes.

In this sense, we sought with the development of online activities with the use of Excel spreadsheet, three data and a fictitious ballot, where they discussed the teaching of statistics with a proposal for an investigative class and created activities to lead students to build the concepts of mode, mean, median, average deviation and measures of dispersion.

Therefore, this is an experience report in which we reflect on the possibilities for teaching statistics in Basic Education through the game of dice and fictitious ballots, in an experience with 20 mathematics teachers inserted in a formative process.

The objective of the game was to enable the expansion of the professional knowledge of participating teachers about statistics in Basic Education, through games, as well as discuss and create essential activities according to the BNCC (2017) guidelines.

II. MATERIAL AND METHODS

The major research that subsidizes this article was developed with qualitative methodology of the Design Based Research type, according to Cobb et al (2003). This methodology is characterized by flexibility, for allowing modifications along the research route, based on feedback received from each teaching experiment developed, they are the re-designs, which allow correcting directions along the continuing education and research. The contributions of continuing education to the professional knowledge of teachers were analysed. The training focused on the teaching of probabilities by investigative classes. The methodological procedures of data collection during training, were by observations data production occurred from the interaction with participants through the Classroom (https://meet.google.com), where we build graphs (histogram and normal curve) in Excel spreadsheet, from the results of the sample space coming from wttps://www.dados-online.pt/. The data collected were analyzed using the content analysis method, according to Bardin (1979), considering the stages: pre-analysis, material exploration and treatment of results.

The present investigation was developed with a group of 20 mathematics teachers of basic education. It is of a basic nature, with a qualitative approach. From the point of view of the objectives, it is an exploratory research.

According to Kauark, Manhães, & Medeiros (2010) basic research aims to generate new knowledge, useful for the advancement of science without expected practical application.

We classified this research as to its approach and objectives, according to Gil (2010), as qualitative of exploratory nature, the author states that exploratory research enables: approach the researcher to the subject and object of study; build important questions for the research; provide an overview about a certain fact or problem; deepen preliminary concepts on a given subject; identify a new aspect on the subject researched.

2.1 - The Activity: Three Dice and Dummy Ballots

The following is an account of the episode with the teachers in which the activity was discussed.

We asked the participants to play on the wttps://www.dados-online.pt/ page and let us know the results of the sum of the three dice. We entered the results into a frequency distribution table in an Excel spreadsheet.

We showed them that the game can be adapted for face-to-face activities, so that it can be divided into teams, each of them with sets A or B, made up of the numbers A = {2, 4, 5, 8, 10,11}, B = {1,3, 6, 7, 9,12}. If it is two dice and if it is a game with three dice, the sets must be evaluated in order to evaluate the number of possibilities of sum.

We explain the notes of a dummy coin (relas), according to the model in figure 1, with notes from 2 to 18. The banknotes are optional, but they add dynamics to the game and can be adapted for primary schools activities, since they allow the four operations to be worked on, among others.

Fig. 1: Some of the dummy banknotes and activity data.

We explained that the numbers within the sets were the possibilities of the results of the sums of the dice rolled from 1 to 6.

We explained that, in each round of the game, the team would be considered the winner if the sum of the dice equaled any of the numbers in its respective set. The team that wins the round keeps the ballot with the corresponding value in its bank. For example: If I choose set B and in a certain round, one dice shows the number 3 and the other the number 6, their sum is 9.

Although we knew that we would never have sums greater than 12 on the roll of two dice, the notes were purposely made from 2 to 18, so that notes 2 to 12 could be distributed to groups, and so that at some point one of them would be missing from the groups. Grades 2 to 18 were discussed later in the three-dice game we will present.

The results of the sums were fed into an Excel spreadsheet, and a histogram with their respective frequencies appeared on the board. Thus, we started with the teachers a moment of reflection with fictitious ballots about which contents of statistics and which grades could be worked on.

III. RESULTS AND DISCUSSION

In this episode, through the experience of the investigative activity of the game of three dice, the teachers participating in the training process had the opportunity to develop an experiment that caused an unbalanced situation regarding the expectation of results.

We presented to the participants the possibilities of the sum of three dice observing the regularity of table 1. The numbers 1, 2,...6 in row 1 are the faces of the dice and then the possibilities that they have in the roll of three dice.

Soma	1	2	3	4	5	6	Possibilidades
3	1						1
4	2	1					3
5	3	2	1				6
6	4	3	2	1			10
7	5	4	3	2	1		15
8	6	5	4	3	2	1	21
9	5	6	5	4	3	2	25
10	4	5	6	5	4	3	27
11	3	4	5	6	5	4	27
12	2	3	4	5	6	5	25
13	1	2	3	4	5	6	21
14		1	2	3	4	5	15
15			1	2	3	4	10
16				1	2	3	6
17					1	2	3
18						1	1

Table 1 - Regularity of posting possibility.

Figure 2 shows the results of 500 throws of three dice, carried out using https://www.dados-online.pt/. The sums 10 and 11, had a higher frequency and the extremities with much lower frequencies, although they are random events, these results, receive influence by the smaller possibilities.

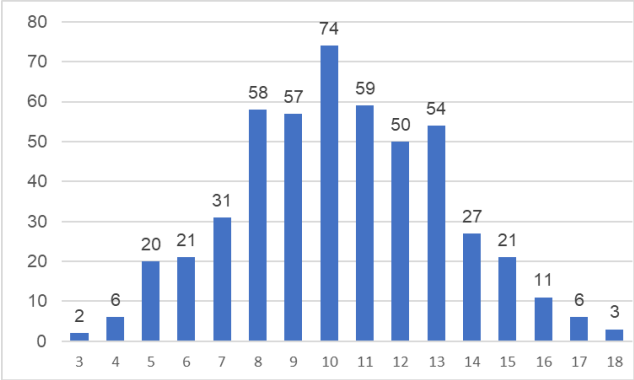

Fig. 2: Result of 500 throws of three dice.

We present in table 1 below the result of 1000 entries.

Lances	Dado 1	Dado 2	Dado 3	Soma
1	4	4	4	12
2	5	1	6	12
3	1	3	3	7
4	2	4	3	9
5	4	4	4	12
6	6	1	2	9
7	4	6	6	16
8	1	3	4	8
9	4	6	3	13
10	4	5	1	10
11	4	2	1	7
12	6	5	1	12
13	6	3	5	14
14	5	2	6	13
15	6	4	6	16
16	1	3	3	7
17	1	1	3	5
18	6	6	1	13
19	6	6	5	17

Soma	F	%
3	1	0,1
4	15	1,5
5	37	3,7
6	41	4,1
7	66	6,6
8	99	9,9
9	116	11,6
10	130	13
11	135	13,5
12	107	10,7
13	109	10,9
14	58	5,8
15	46	4,6
16	25	2,5
17	13	1,3
18	2	0,2
Total	1000	100

Table 2 - Result of 1000 throws of three dice.

We can observe in figure 3 that the central part has close frequencies, we explain that this phenomenon should be used to address the law of large numbers. The extremities continue with a lower frequency, even with the increase of launches, the sums 10 and 11 that are part of the central position and have a high number of possibilities, continue with a relatively high frequency.

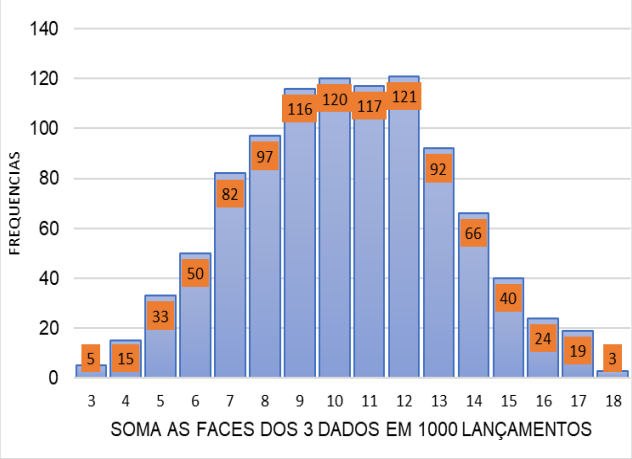

Fig. 3: Sum of the faces of 3 dice in 1000 throws.

In figure 4, we take the opportunity to address concepts of the normal distribution, including the possibility of discussing this subject with high school students.

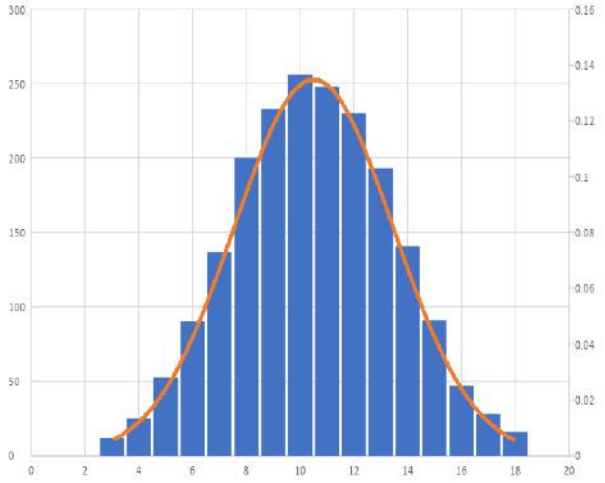

Fig. 4: Normal Distribution

We consider that the proposed activity provided the production of meanings about investigative activities, promoted reflections on aspects inherent to teamwork, also on the importance of continuing education, as well as on methodology for statistics teaching. The reflections were focused on the importance of teaching focused on the participation of students as active agents in the construction of concepts and appropriation of definitions.

IV. CONCLUSION

At the end of the meeting, it was evident that participation in the training could expand the teachers' professional knowledge about statistics, as well as an opportunity for reflection on their practices (didactics) in class, providing the opportunity to insert investigative lessons to address the concepts of statistics.

Teachers pointed out that it could be worked in a way to adapt games, but with respect to statics, we could work in Basic Education:

- Identify, in familiar random events, all possible outcomes, estimating those with higher or lower chances of occurrence;

- Promote the understanding that not all phenomena are deterministic;

- Organise the data collected using lists, simple tables;

- Counting;

- Luck x chance (Probability);

- Measures of central tendency and dispersion.

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