LET'S LEARN STATISTICS PLAYING

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Initial education is considered as a stage of construction and a transmitter of culture that will – through a variety of games – enable children to explore the world beyond the learning that develops at the affective core. Teaching statistics should start as early as possible. However, in Argentina, teachers at initial level lack sufficient statistical knowledge. We designed a teaching experiment with teachers responding to their lack of knowledge, where all activities are fostered around games. The experiment was carried out in Rosario in 2018 with teachers of classes of 4 and 5 years old children. These teacher-students were taught notions of statistics in such a way that they would be able to put into action what they had learnt. We present some of the activities that were done by the children and will analyse the reports that the teachers handed in. The surprising results indicate that statistics and games can establish a profound relationship in the children's minds.

INTRODUCTION

It cannot be denied that the twentieth century has been the time of Statistics, which has started to be considered as one of the fundamental methodological sciences and the foundation of the experimental scientific method.

Statistics teaching, however, does not seem to follow the same path, even though there has been a particular increase in the use of statistical ideas on different fields in the last decade that can be observed in scientific magazines and in the increasing implication of statisticians in interdisciplinary work teams. At the recent Conference Icots 9 held in Flagstaff, Arizona USA Batanero (2014) on the instruction of investigators it was highlighted that statistics is being used in the wrong way since there is no understanding of basic concepts and there is not enough appreciation of the statistician's job among the investigation teams.We believe this shows the existence of an educational problem since the incorporation of statistics in the syllabuses is not yet a fact. Even though it is already included in the syllabuses of Primary and Secondary Education, teachers generally leave this topic for the end of the year and many times it ends up being overlooked. Students reach university without the basic knowledge and it is necessary then to start repeating the contents of descriptive statistics and calculation of probabilities that should have been incorporated at school.

Initial Education is a space of subjectivity and social responsibility, it is a time and space that receives and embraces children from three to five years of age, a first encounter with the school organization of the educational system. Initial Education, as a builder and transmitter of culture will allow children, through games, to explore and appropriate the world that opens up beyond the affective core and family learning, developing personality foundations in a period of conquests with such an intensity that they will never be the same.

Initial Education fosters the development of different languages of expression: expressive, physical, communicative, symbolic, playful, cognitive, ethic, affective, metaphoric, logic, imaginative, relational, among others. At this stage, we can observe a child who is powerful, energetic, and who has the ability of self-construction while they transform the world, with the strength of those who grow and wish to grow, with the wealth of curiosity and surprise that leads them into asking the whys of everything, at the peak of their senses, original, creative, with the desire to learn and live. It is here where the teaching they receive about the first notions of Statistics play a fundamental role. Batanero (2002); Garfield and Ahlgren (1998); Kapadia and Borovcnik (1991) and Shaughnessy (1992) in their investigations hold that statistical learning implies some activity by the student, who has as a starting point, problem solving.

Piaget (1973) sustained that from Initial Education there should be implemented a series of steps that will help to understand the problem in such a way that it constitutes a sequence of their learning. Problem solving means to compromise knowledge, experience, reflections and their relation to the near context so that everything makes sense. All mathematical learning has the aim to appropriate the contents by means of some problem solving.

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At kindergarten, children boost their motor, cognitive, linguistic, and social skills, and play with them all. They are eager to learn by themselves and they are much more independent.

As outlined by Piaget in his theory, the four-year-old child is at preoperational stage:

- Their learning, apart from being syncretic, is intuitive and concrete. Their world is that of concrete emotions, though the first signs of rudimentary abstractions are perceived. The organization of representation is based on the assimilation of their own action, an egocentric foundation.
- They like games where they can recognize and match colors, shapes, sizes. Letters and numbers begin to arise an interest in them because the child discovers them in their family and social world, they start to build many hypotheses in relation to these two forms of knowledge.
- The notion of quantity and number is purely intuitive; they can count up to 10, but they will only realize that five is more than three when they have the concrete shape in front of them. They neither relate asymmetrically nor make inclusions of numeric classes.
- They recognize colors, sizes, shapes and positions in images.
- They can classify by one feature first and then by two.

In maths we start from the questions: Which attitude does the student show towards the search and solution of mathematical problems? Up to which number can he count? Can they determine how many objects there are in a collection? Can they mention quantities by counting? Do they use numbers to develop any game or activity? Can they say the numerical series orally? Up to which number? Do they use games to mention positions? Do they use or mention spatial positions: above, below, near, far, others? Do they recognize the distinctive features of some shapes or geometrical bodies? Do they recognize names? Do they utilize conventional and non-conventional measures?

In five-year-old classrooms apart from the questions mentioned for four-year-old classrooms, we can add: Do they manifest any recurrent change when counting? Do they use and name other relative references: above from, behind the, others? Can they interpret or graphically record these positions? Do they utilize the adequate measurement instruments for an activity or situation?

The questions posed for these two classrooms (four-year-old and five-year-old) were analyzed by Wertsch (1998) who claims that when we talk about representations, we have to consider, apart from the written and oral language, other signaling systems such as: counting systems, memotechnic rules, algebraic symbols, plans, diagrams, maps, drawings and all sort of conventional signs.

At a five-year-old classrooms teachers can start with graphic and symbolic language from everyday situations, trying to bring the student closer to the measurement of social practices and linking this emerging knowledge with a mathematical endeavor, discovering the different contexts where measurement is a tool to solve different situations. The first notions of descriptive statistics are here incorporated through simple graphs.

Lemke (2002) holds that science considers the languages of visual representation, of mathematical symbolism, and of experimental operations. At this stage he observes that the natural language of sciences is a combination of words, diagrams, images, graphs, maps, equations, charts and other forms of visual and mathematical expression.

For Arteaga, Batanero, Ortiz and Contreras (2011) working with statistical graphs allows to simultaneously develop the numerical sense and the ability for information treatment.

METHOD

It is here presented an experience that took place and is taking place in the city of Rosario, in a private school at initial level where 120 students divided into 4 classrooms assist. The experience was carried out with 15 teachers who implemented in their classroom what they had learnt. This experiment has been outlined on the guidelines by Gardner (2000) and Davini (2008). The director of Zero Project at the Education Faculty of Harvard University, claims that: “The teacher should not only look for the opportunities for the student to develop their thinking, but they should also create and model them.” For the Zero Project the following was considered:

1) *Understanding as performance:* the ability to think and act flexibly from what we know to solve problems, creates products and interacts with the world around us. The learning process implies not only to obtain and receive, but also to build knowledge together. It is a social process.

2) *Thinking as disposition:* we can learn to think and for that a set of capabilities, opportunities and motivation has to be provided. Each kind of thinking has capabilities, for example, the capabilities to

think critically are different from those from another kind of thinking. Each kind of thinking has connections of motivation. An example of this in relation to initial level could be the following dynamics:

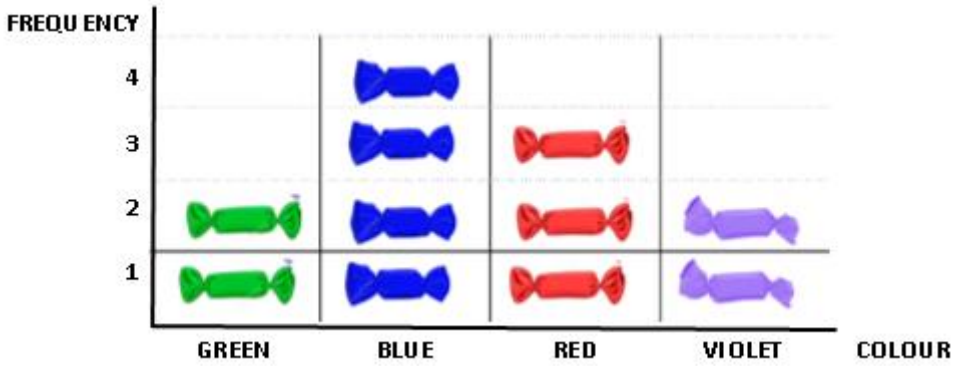
1) show something (a graph) to students,
2) ask them to think individually in relation to its meaning,
3) ask them to formulate questions or theories in relation to what they saw.

Based on these guidelines, we present some ideas that were analyzed with the teachers and implemented at school.

Activity 1: We play with colours

A bag of candies of different colours is distributed among the students. Each student will put the color of their candy wrapping where it belongs in the graph that will be fixed to the board so that together they can complete it, analyze the results and reach some conclusions.

Table 1. Frequency of colours of candy



In this way there is a first approach to a bar graph, they can highlight which one is mostly repeated and compare them so that the child can have the first tools to start analyzing a graph.

Activity 2: How do we feel today?

Here we present a table where the teacher will record their emotions by sticking a face that identifies our emotional state one day, for instance.

Table 2. Frequency of emotional state one day.

In this way the children gather concrete data of their daily life. They start recording and organizing such information. The data in the graph is read and interpreted answering questions like: how many children were happy today?

Activity 3: Who will be the winner?

From the fable by Esopo "The turtles and the hare" we bring the race to the classroom. We divide the group into two: turtles and hares. Each player will throw the dice so that they can move forward and whoever arrives first will be the winner. The movements will be recorded in a chart.

Here we present the movement of the dice of one player of each group.

Table 3. Frequency of movements of one turtle and one hare

	X	X	X	X				
	X	X	X	X	X	X		

With this activity we are creating diagrams with crosses that will indicate the forward movement of turtles and hares. We are working with representations, sign systems to count and other relations are established through oral language.

Activity 4: Of which shape and colour do we bake more?

We prepare cookies using dough of different colours and different shapes. Once baked we record from which one we got more taking into account both colour and shape.

Table 4. Frequency between colours and shapes

COLOURS OF STARS / SHAPES OF FIGURES			
	IIII	II	I
	II	I	III
	I	III	IIII
	I	III	IIIIII

Here quantities are designated by tallies, the game is used to name positions between shapes and colours, distinctive features of some geometrical figures are recognized and such information is recorded in a double-entry chart.

Activity 5: What's the weather like this month?

In this activity the student draws the information related to the weather during a whole month. Together with the teacher, with the aim of incorporating the basic concepts of descriptive statistics, the student analyses the information, gathers and interprets the results. The teacher asks questions like: how many days were sunny?, which weather was less recorded?, were there more rainy than cloudy days?, which weather is repeated the most during the month?, can you determine this value?, where can you take it from? The teacher explains that the data that is most repeated is called Mode, since

among the measurement of central tendency, the Mode has a concept that is easy to understand and identify.

Table 5. Frequency of the weather in a month

Day / Weather	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	TOTAL
SUNNY	XX		XX		XX	XXX	X	10
RAINY	X	X	XX		X	X		6
CLOUDY	X	XXXX	X	XXXX	X		XXX	14

RESULTS

According to Piaget, in cognitive development, children from 2 to 7 years old are in the preoperational stage. This is the stage of thought and language that graduates his ability to think symbolically, imitates objects of behavior, symbolic games, drawings, mental images and the development of spoken language.

Once the 5 activities were completed, the teachers were asked to complete a report per student according to what was observed in these activities. The report was prepared according to Piaget's intelligence and learning guidelines and the Likert scale was used for the initial level, where the answers were categorized into: expected accomplishment, in process and in the beginning. Once the reports were submitted, out of a total of 120 students, the results were counted and expressed in percentages. The results obtained from the reports are presented below in the following table.

Table 1. Results of childrens' reports

COGNITIVE DEVELOPMENT. PREOPERATIONAL STAGE. GUIDELINES	REPORTS: INITIAL LEVEL		
	ACCOMPLISHED THE AIMS	IN PROCESS	DID NOT ACCOMPLISH THE AIMS
Acquired the ability to mentally represent an object that is not present	83%	12%	5%
Managed to distinguish between his own perspective and that of others.	81%	10%	9%
Certainty was observed in choosing the right figure	75%	20%	5%
Managed to identify symbols with real objects	91%	6%	3%
Managed to classify different elements	95%	5%	0%
Language and communication improved	89%	10%	1%

CONCLUSION

By the experience carried out with teachers and the reports that they presented afterwards with the results of the childrens' achievements, it can be concluded that children develop capacities and promote the development of multiple forms of language: expressive, communicative, symbolic,

playful, cognitive, ethic, affective, metaphoric, logic, imaginative, relational, where the teaching of the first notions of Statistics play a fundamental role in their learning.

It is important to highlight that by playing, reading books to them, children are already capable of interpreting information given in graphs, maps and charts; and without defining specific concepts we can introduce notions of mode, graphs, frequencies, central measurement, data scattering.

One of the major drawbacks is that at initial level there is no literature that includes the teaching of statistics, only random exercises that would not raise any motivation either in the students or the teacher. Batanero, Arteaga and Contreras (2011) point that a similar situation takes place in Spain.

Here is where the importance of such an experience resides. It is crucial that teachers should be trained in statistics so that they can later on plan their teaching and apply the concepts acquired in their classes, since the big problem lies in the scarce instruction on statistics that initial level teachers have, even though it is included in their maths syllabus.

A good teacher needs to know the importance of teaching statistics at this level since they will form a child that will be able to interpret information, analyze data, establish relations between variables and elaborate conclusions, arising from early childhood a critical spirit.

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