

## TEACHING STATISTICS IN BRAZIL

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*Teaching of Statistics began in Brazil forty five years ago. Since then, several Statistics courses have been established in higher education institutions, at both undergraduate and graduate level, some of them oriented to theoretical, others to applied Statistics to social, demographic, economical, business or biological sciences. Specific careers, like Engineering, demand mandatory courses in Statistics. What is the profile of the "ideal" professor for such courses: traditional academic or practical Statistician? For mathematical educators some basic notions of probability, sampling and inference, so intensely present in everyday life, cannot be ignored in high or even elementary schools. The efforts in this direction are surveyed.*

### INTRODUCTION

With its 8.5 million km<sup>2</sup> of territory and 160 million inhabitants, Brazil is the fifth largest country of the world in size, the sixth largest in population, and the largest in South America. Its predominantly young population concentrates along the Atlantic coast, where are the two largest cities, São Paulo, with more than 15 million people in its metropolitan area, and Rio de Janeiro. The literacy rate is 81.7%. Brazil's economy is the tenth largest of the world and the largest in Latin America, with GNP about 2.5 times as large as Mexico's, with per capita income about US\$5,000. Economical activity concentrates in the southeastern region, where the State of São Paulo - one in 26 States - is responsible by 50 percent of the industrial production.

The number, type and concentration of higher education schools in Brazil are shown in Tables 1 and 2. It can be seen that more than 77% of the higher education schools are concentrated in the Southeast and South regions, with amazing 63% only in the Southeast region.

The discussions regarding the models and proposals for reorganizing the educational system in Brazil are guided by the search of solutions to the following problems: i) how to maintain all students in school without loss of quality; and ii) how to cope with the challenge of qualifying the students to the job market in this time of worrying rates of unemployment.

Table1. Higher Education Schools in Brazil by Regions

Region	Total	Universities			Colleges			Individual Schools		
		Total	Public	Private	Total	Public	Private	Total	Public	Private
BRAZIL	851	127	68	59	87	3	84	637	147	490
North	23	9	8	1	-	-	-	14	4	10
Northeast	88	26	22	4	4	-	4	58	17	41
Southeast	539	57	19	38	63	-	63	419	75	344
South	122	26	13	13	9	3	6	87	28	59
Center	79	9	6	3	11	-	11	59	23	36

Source: Ministry of Education

Table 2. Concentration by Regions of Higher Education Schools in Brazil

Region	Total	%
BRAZIL	851	100,0
North	23	2,7
Northeast	88	10,3
Southeast	539	63,3
South	122	14,3
Center	79	9,4

Source: Ministry of Education

Many efforts are being undertaken to prepare citizens for living and working in a modern global society. But the existing dramatic regional differences make absolutely necessary to search for several tentative solutions for similar situations.

#### STATISTICS TEACHING IN GRADUATE PROGRAMS AND UNDERGRADUATE COURSES

The first university level course for graduating Statisticians was created in Brazil forty five years ago, in Rio de Janeiro, under the auspices of the Brazilian Census Bureau. Since then, many similar courses have been established in federal, state or private

Universities. At this moment, many graduate programs and undergraduate courses, such as Engineering, Physics, Chemistry, Mathematics, Medicine, Psychology, Biology, contain in their curricula disciplines in Statistics, dealing at least with the fundamentals: Descriptive Statistics and notions of Probability. Some of these courses are oriented to theoretical Statistics, others to applied Statistics in the fields of social, demographic, economical, business or biological sciences.

The theoretical approach is adopted in two types of situations: first, in courses for graduating statisticians; second, in Master and Doctoral programs for several branches of science. At the undergraduate level, the students that plan to work in professional and academic Statistics activities attend a course where the foundations of Statistics are stressed, with emphasis on Mathematics. The same approach is followed by other graduate programs, like Engineering or even Biology, to cope with the evolution of these and other sciences, which is increasingly demanding the study of sophisticated statistical models. From the point of view of teaching, this situation poses a challenge, as it increases the gap between basic Statistics taught at the undergraduate courses and the theory demanded in graduate programs.

The applied Statistics approach is emphasized most of the time in the undergraduate courses of specific areas. In Engineering courses, it is obligatory the teaching of all the statistical subjects, that is, Descriptive Statistics, Probability, and Inference, and, most of the time, advanced topics, such as Statistics Process Control and Design of Experiments. In Psychology courses, the students are urged to enroll non mandatory Statistics disciplines, because its techniques are needed in analyzing psychological tests. Future Mathematicians generally have a semester of Probability and Statistics as introductory courses. It must be stressed that in many courses only Descriptive Statistics and Probability are studied, missing the most important aspect: Statistical Inference.

#### STATISTICS TEACHING IN HIGH, JUNIOR HIGH, AND ELEMENTARY SCHOOL

During the last years, awareness has been increasing among mathematical educators in the sense that some basic notions of probability, sampling and statistical inference are so intensely present in everyday life that they cannot be ignored in high, junior high and even in elementary schools. Of course, this can only be done if teaching of mathematics leaves the frame of a rigid sequential order, allowing e.g. the study of the

area below a histogram by visualization, and not through integral techniques. In high school curricula, it is already usual that notions of Probability and Statistics must be taught. Generally, high school teachers must teach these notions without having an academic theoretical basis nor a professional experience. Fortunately, in some teachers' education courses, future secondary teachers of Mathematics already have a semester of Probability and Statistics, at an introductory level.

It is urgent to educate teachers at all levels in the basics of Statistics, otherwise their students can internalize wrong concepts and, by the time they have to apply the concepts to a decision making, they can make a wrong decision, although based on premises they think are correct.

#### DISCUSSIONS AND DESCRIPTIONS OF SOME EXPERIENCES

It seems ideal that only specialized teachers could teach all the Statistics disciplines. In Brazil this is not possible yet, because there are not sufficient professionals to do that, although the government tries to put in practice this regulation. Specially in poorer regions of the country, it is still tolerated for professionals of different backgrounds to teach Statistics (among them we found engineers, doctors and managers).

The teaching of Statistics by so many educators raises some very interesting questions, from the point of view of Science Education. For instance: depending on the specific course, what is the "ideal" professor? One who has a traditional academic profile, or one who actually practices Statistics in his/her professional activities, or one with a solid mathematical and statistical basis but deeply committed to education?

Evidently, the teacher with a traditional academic profile, with a strong theoretical basis, has more opportunities to update himself in the latest advances in the field, and can discuss some specific problem with academic freedom with many people from different origins, quite differently from a professional working in an organization, whose main goal is to seek profit, and so has to be careful in sharing his ideas with their competitors.

On the other hand, practical Statisticians are committed, in a daily basis, not with ideal models but also with real problems, having more ease in tackling problems, as they can see a myriad of uncontrolled variables, and the found solution must be implemented satisfactorily.

Of course, the advantages of one aspect are the disadvantages of another. The

challenge is to combine the professor's educational background in Statistics with the demand of the organizations for a practical approach of teaching. Efforts are being undertaken to provide opportunities to different professionals of interacting with Statisticians in several ways. An interesting experience has been done at the aforementioned School, maintained by the Brazilian Census Bureau, whose main interests are in Statistics applied to Social Sciences, specially Demography. Often statisticians or demographers who work in the Bureau, but have an academic profile, give courses at the School. Reciprocally, some of the professors of the School have been called to work in the technical area of the Bureau, in the domains of Sampling, Mathematical Demography and Statistical Data Analysis.

However, it seems that great emphasis must be given in the statistical education of high and junior high school teachers, where most of the fundamental concepts begin to be taught. Most teachers restrict themselves only to how to build graphics, without interpretation of the data. However, they are often challenged by their students regarding the interpretation of phenomena, and also how to explore the concepts of probability and statistics. Young people want to understand what they see and listen in the media. "Can we trust the opinion polls?" "Why none of the people from my family have ever been interviewed?" If the teacher at that level doesn't have a sound theoretical basis, it can be difficult to explain the concepts necessary to answer such questions.

High school textbooks tend to be limited to compute probabilities in problems involving cards, coins, urns, without connection with the Statistics the student sees in real world. No attention is given to geometrical probability problems, which are very motivating and not difficult to solve in one or two dimensions. No reference is found to Statistics Inference, the most important subject in the whole area. Textbooks examples need to be reviewed, in such a way that the student can feel the importance of using statistics in real life.

As a positive movement, in 1997 the Ministry of Education published the National Curricula Parameters, providing guidelines for all subjects to be taught at all levels of teaching, including Statistics. That document stresses the importance of Statistics to forecast events, and encourages teachers to present data through tables and graphs; to introduce elementary notions of statistics and probability, respecting the students' level of development; to use real problems, formulating hypothesis, planning and performing investigations; to analyze data; to establish and criticize conclusions.

These guidelines are a strong motivation for programs aiming to qualify teachers regarding the basic concepts of Statistics: Descriptive Statistics, Probability and Inference, emphasizing statistical concepts, and not only resolution of “book problems”.

In the setting of a project sponsored by the Brazilian Government, a successful experience was done at Santa Ursula University. A team of professors from the Master Sc. program in Mathematical Education trained approximately 100 secondary teachers in the concepts of Statistics, with the innovative approach of using spreadsheets for computations and graphics, and using real life examples for high school classes. The assessments done by the students/teachers made clear the usefulness of the training for their daily practice in classes.

Another team of the same University, with the collaboration of Professor Carolyn Maher from the Rutgers University of New Jersey, is conducting an experience in teaching Statistics to children from 9 to 13 years.

## CONCLUSION

The teaching of Statistics in Brazil began at the undergraduate level, and gradually evolved to graduate and undergraduate courses oriented to theoretical or applied Statistics. Nowadays, basic notions of Statistics are becoming common in high, junior high and even in elementary school. These new efforts are starting in Brazil, with an eye to the future of educating the 21<sup>st</sup> century professional which will calculate yearly the tenth Gross National Product in the world - while coping with this country's huge regional and social differences.

## BIBLIOGRAPHICAL NOTE

We will omit Brazilian bibliography on the subject, which besides being in Portuguese, is very sparse.