TEACHING STATISTICS IN BRAZIL

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Statistics in Brazil has slowly been regaining its prestige, both in educational and academic scope, because of its importance in the scientific and ethical formation of the citizen and its growing applications in a society with increasing levels of knowledge. This is evidenced by the guidelines contained in the Brazilian National Curricular Parameters for elementary and secondary education, which includes, for the first time, statistics teaching from childhood. However, the teachers who are pedagogues and undergraduates in Mathematics (responsible for this job) have not been prepared for this challenge. This paper analyzes the present state of research in Statistics teaching in Brazil, by focusing on elementary and secondary education and the training of teachers. We conclude that it is necessary to rethink the training of Mathematics teachers in elementary and secondary schools, to consolidate the research groups, and to make it possible to socialize all the knowledge gained at school in order to reach a higher level of statistical literacy.

PRESENTATION

Statistics Education in Brazil was pioneered at the International Conference whose theme was "Experiences and Expectancies in Statistics Teaching – Challenges for the 21st Century," held at the Universidade Federal de Santa Catarina (UFSC, 1999) and now it begins to take shape as a research area tending to solid growth. The need to answer the problems found in teaching statistics concepts and procedures is mainly due to the authorization of its teaching in Elementary and Secondary courses, through the PCN (Education Ministry-MEC, 2005a). In national and regional events regarding Mathematics or Statistics Teaching, there is a growing number of Mathematics teachers in Elementary and Secondary Courses who are searching for mini-courses, workshops and experience reports in order to find material and methodology that allow them to study these concepts and procedures, because there is a gap in their undergraduate course. Nevertheless, the results of researches regarding statistics teaching are few in the academic environment. This paper presents a brief history of Statistics teaching in Brazil, listing Institutions, groups and researchers that are working in the area. It is a descriptive paper and its objective is to map the research done in this field.

The data collected in the internet were: on undergraduate-level courses in Statistics in the MEC homepage (2005b); on Masters and PhD-level courses in the Coordination for Improvement of University personnel level (CAPES, 2005); on the Universities, dissertations and thesis, from the homepages of these institutions; from researchers and research groups of the "Plataforma *Lattes*" (The Lattes Platform (http://lattes.onpq.br/) two systems were used: the Electronic Curricular System, which collects curricular information in a standard format and the Directory of Research Groups in Brazil, which contains the human resources used in groups, the lines of research in progress, knowledge specialties, sectors of application, Masters and PhD courses with which the groups interact and the scientific and technological production captured from the electronic curriculum system.); from societies and events; from sites, summary books or annals.

Papers published in books or magazines or regional and national events were analyzed in order to find the researchers, then their Curriculam Vitae from the "Plataforma *Lattes"* were broadly scanned to verify the existence of related studies, after that e-mails were sent to these researchers requesting additional information. Unfortunately, this data cannot be discussed in this study, but will be shown on *Via Litterarum* homepage (http://www.vialitterarum.com.br/Educação_Estatística). In this paper it is seen that Statistics embodies the theory probability and is a synonym for stochastic.

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In Brazil the history of statistics teaching is associated to the history of the Brazilian Institute of Geography and Statistics (IBGE), which was created in the 17th Century. The teaching

of statistics started at the end of the 18th Century, and is linked to the calculation of probabilities used in the military engineers training (ABE, 2005).

Statistics was introduced in other different courses, such as Agronomy, Medical and Social Sciences, among others. These subjects, known as service courses (Wada, 1996), have as objective the training of several professionals (users) in the proper use of statistical tools. The first undergraduate course in Statistics was created in the Universidade Federal do Rio de Janeiro (UFRJ) in 1946 and today, according to MEC (2005a); Brazil has 26 officially recognized undergraduate courses (Not included: the undergraduate-level course in Statistics offered by the UFRGS, recently extinct, and the course in Economic Statistics of USP, which is branch of the course of Applied Mathematics. We observe the existence of two Masters and PhD courses in Agronomy, one emphasizing Statistics and Experimental Agronomy, at the Luiz de Queiroz Higher School of Agronomy-ESALQ, at USP, and the other, in Statistics and Farm Experimentation at the Federal University of Lavras-UFLA.), 7 Masters courses (USP, UNICAMP, UFSCar, UFMG, UFRJ, UFPE and UFPA) and four PhD courses (USP, UNICAMP, UFMG and UFRJ). Just one course of specialization (*latu sensu*) in *Statistics Education* was found; at the Jorge Amado Faculty in Salvador, Bahia.

In Elementary and Secondary Education, the Statistics program is part of the Mathematics course and, because it used to be one of the last topics of the textbooks, it was hardly ever studied (Panaino, 1998). Today, this situation has essentially changed. According to Cazorla (2002), the PCN emphasizes the need to communicate, to solve problems, to make decisions, to make inferences, to act as cautious consumers or to make decisions in their own private and professional lives. Positive attitudes towards Statistics must be developed in order to make people "understand the importance of Statistics in human activities but that it can also induce to judgment errors, by the manipulation of data and by incorrect presentation of information (absence of relative frequency, inadequate table scales)."

The topics related to Statistics are in "Treatment of Information themes" which is one of the five themes of concept contents and procedures in the teaching of Mathematics and it is well regarded in the PCN. The courses include reading and interpretation of statistical information; collecting, organizing and making summaries and presenting information; making tables, charts, calculating and interpreting the measurement of central tendency and dispersion, as well as first principles of the probability theory. The PCN suggests that this should begin at Elementary students level.

THE GRADUATION OF STATISTICS TEACHERS

The training of Statistics Teachers can be categorized into two groups, as follows: University Education and Basic Education. In the University level it is necessary to distinguish the Statistics teaching for Statistician training from the users training. In basic Education two segments should be distinguished: one formed by Elementary Education and another by Secondary and High School Education.

In the University level, according to the curriculum guidelines for Statistics courses, the statistician should be proficient in handling common *problems in this area, such as: collecting, organizing and synthesizing data, adjusting models – and being able to search for information in order to solve new problems and, when finding them being able to understand and implant them* (MEC, 1999). It boards three professional profiles: the academic, that should continue studies and post-graduate courses and teach in universities and work in research centers; the applied statisticians working with other professionals, and those who will dedicate themselves to the broadening of statistics knowledge in different social organizations, but specially in Elementary, Secondary and High school.

It's important to point out that there are hardly no Statistician teaching in Elementary, Secondary and High School because there is no such program at this level of Education and the only Statistics undergraduate responsible for teacher training has been closed down.

The Statistics user is graduated in a variety of courses that uses Statistics as a tool. Some courses offer only one subject, most often, limited to the exploratory analysis of data; others offer two, including statistical inference and others offer three, the last one aiming at the specific area of each course, for example, experimental design, time series, quality control, among others. In

this study, two programs have special importance for the analysis of Statistics teaching: Pedagogy that trains teachers to teach Statistics in Elementary schools and Mathematics which prepares to teach in Junior High and High schools.

In Universities where there are undergraduate courses in Statistics, there is usually a Department of Statistics that binds together teachers and subjects of the area. The teachers must be graduated in Statistics or in a related area with a masters and/or PhD course in Statistics. (According to the Law of Guidelines and Bases for Education (LDB, 1996), university teachers must have at least a Masters degree. This is complied with most strictly only in large university centers.) In other universities, the majority of teachers have a Masters and/or PhD in courses where Statistics is used to some extent, such as Economics, Engineering and Agronomy.

Analyzing the curricular form of Statistics undergraduate, Masters and PhD programs, it is easy to see that the programs are focused on the statisticians training, regarding content. It is rare to see courses that have subjects or programs aiming at the pedagogical training of these teachers. The same happens when analyzing the curricular form of the courses in areas related to Statistics. The mastering of the content is a must for teaching, but if the teacher is not able to teach these contents clearly, the learning process can be a failure.

The dropping-out rates (defined as the percentage of students who started the course and left after a time) in Statistics undergraduate courses have reached alarming levels. At Universidade de Campinas - UNICAMP, in the period from 1970 to 1991, the level was 56%, when the general dropping-out rate was 22% (Faggiani, 1994). This situation, from 1993 to 2003, has improved a little, but the average dropping-out rate is still around 30% (UNICAMP, 2004). A similar situation was experienced in Universidade Federal de Minas Gerais - UFMG (2005) in Statistics course, when the dropping-out rate reached 90% in 1992.

To change this situation, Statistical Laboratories, monitoring and the participation of students in projects were implanted. The advance of technology information has helped in this sense, because many courses use and develop software, applications and develop homepages, where students can find material and learning endorsement, apart from changes in the curricular form (MEC, 1999).

Some universities have implanted a pedagogical formation of university teachers programs. For example, UNICAMP implanted in 2000, the Program of Didactic Endorsement (PAD) for undergraduates and the Apprenticeship Program of Teaching Training for postgraduates. USP has similarly implanted in 1992, the Improvement of Teaching Program (PAE), whose main purpose is to prioritize the formation of the postgraduate student for teaching undergraduates, through the Pedagogical Preparation and the Supervised Traineeship in University.

In the Statistics users training, serious problems are observed. The most affected courses are from human, social and applied sciences and the most obvious problems are: the precarious mathematical level of the students, negative attitudes regarding Statistics, the excessive emphasis on calculation, language and mathematical aspects of statistical methods and lack of computer laboratories, among others (Fernandez and Selau, 1999; Gracio and Oliveira, 2005; Mantovani and Viana, 2004; Silva, Cazorla and Brito, 1999).

Gracio and Oliveira (2005) presented a Statistics teaching experience in the Library Sciences, Pedagogy and Social Sciences, using a project methodology that uses practices of investigation and quantitative research and observe that when the statistical procedures were linked to research practice in the student's area of knowledge, the teaching became meaningful for the student. Mantovani and Viana (2004) showed an experiment in an Administration course, using virtual environments with ScreenCam technology, in which explanatory films were used to show how to use statistical tools, using software, and interpreting the results. The students who were challenged to solve problems in the area noticed the usefulness of Statistics in their training. A similar experiment was described by Alves, Montebello, Lacerda and Santore (2004) in Engineering courses.

As for the Statistics program in Pedagogy courses it is observed that some courses offer no Statistics subject at all; others have one and, rarely, two (Gonçalves, 2003). Two subjects are linked to these courses: Educational Statistics (educational indicators) and Statistics Applied to Education, as tools of data treatment and notions of statistical inference. It is observed that none

of these subjects take in Statistics Didactics, which is also not made explicit in the subject of Methodology of Mathematics Teaching. It is noticed that the students in Pedagogy have great resistance to mathematics and statistics content. In some courses, the subject of statistics has completely disappeared.

When analyzing undergraduate courses in Mathematics it is seen that some courses offer just one subject in Statistics and Probability and others, two. If only one subject is offered, the emphasis is on probability theory, at undergraduate level. If two are offered, the course subjects focus on statistical inference.

In short, in the Pedagogue and Mathematics undergraduate training, the Statistics teaching is neither focused on the training of a researcher-teacher, (a teacher that is able to transform his teaching activities into a field of pedagogical researches by using Statistics as a privileged instrument of analysis of that praxis) nor works the contents and methodologies for Elementary and Secondary Education teaching.

RESEARCH RELATED TO THE TEACHING OF STATISTICS

The Brazilian Association of Statistics (ABE) brings together the community of statisticians and aims to promote development, diffusion and use of Statistics in Brazil. This Association organizes the National Symposium of Probability and Statistics (SINAPE) and sponsors other regional congresses (ABE, 2005). It also publishes a bulletin and two technical magazines annually but it has not published articles concerning Statistics teaching. At the 16th SINAPE, in 2004, the ABE created a section on Statistical Education, in which 21 papers (3.9% of the total) were approved and 18 of them related to Statistics teaching; fifteen of them were concerned with University Education and three with Elementary and Secondary Education. On the 15th SINAPE, nine papers (1.7% of the total) presented were related to Statistics teaching and at the 14th SINAPE, there were ten (2.7%). These papers were usually presented at the Statistics section of Social and Human Sciences and related teaching experiences on University students using virtual learning methods, software, scientific paper reading and project methodology, giving emphasis on the adequate use of tools for the solution of problems arising in the program area. There are very few papers approaching the teaching – learning statistics concepts, or that relate them to emotional aspects, such as: attitude, anxiety, among others.

The Brazilian Society of Mathematics Education (SBEM, 2005), gathers all the Mathematics teachers who have been working systematically on problems related to the teaching-learning of Statistics in Elementary and Secondary Education. This Society organizes the National Congress of Mathematics Education (ENEM) and also sponsors regional meetings. On the VII ENEM in 2001, the SBEM created a Work Group called Teaching of Probability and Statistics (GT12). During this event, 19 papers related to statistics training were presented (3.4% of the total) and on the ENEM VIII, 16 papers about this program were presented (3.4% of the total). Most of the papers focused on Elementary and Secondary Education, taking the PCN as reference. Some of the papers approached statistics training of teachers who teach Mathematics at these levels. The SBEM publishes a magazine: Review of Mathematics Education (ERM), and its 17th issue showed three articles on Statistics teaching.

The National Post-Graduate Association and Research in Education (ANPED) (http://www.anped.org.br) has been used as a forum for studies in this area. Created in 1976, it organizes an Annual Meeting, which has held 28 meetings. The Work Group in Mathematics Education (GT19) was officially established in 1999. From 2000 to 2004 it approved 92 papers, 11 of which were related to Statistics teaching. The papers dealt with the reading and interpretation of graphics in Elementary and Secondary Education and also the training of Mathematics teachers.

The International Conference "Experiences and Expectancies in Statistics Teaching - Challenges for the 21st century (Universidade Federal de Santa Catarina-UFSC, 1999) brought together 180 researchers, 110 of these were Brazilians, showing thus the interest of the professional of the area. Sixty-one papers were presented, 28 were from Brazilian researchers (45.5%). Nineteen of them worked at Universities and six in Elementary and Secondary Education and three others who took in all teaching levels. From the papers concerning the University level, six were related to Statistics graduation programs and the others to teaching

Statistics to users. Some papers dealt with attitudes towards Statistics and difficulties experienced by students of other courses, as well as different approaches whose aim was to make teaching more efficient. The papers related to Elementary and Secondary Education was about the teaching of probabilities, using alternative material, and the teaching of Statistics using the project method.

The 9th Seminar on Applied Statistics - IASI, "Statistics in Education and Education in Statistics" (http://www.Ibge1.gov.br/cms/ix_iasi), held in 2003, brought together 166 researchers, (130 were Brazilians). Sixty-one papers were presented, 45 by Brazilians (73.8%) and 21 of them were about Statistics teaching, 16 in the University level and 5 on Elementary and Secondary Education. Most of the University papers dealt with the problems of teaching users. These papers showed the difficulties faced when teaching Statistics to other areas, mainly to those applied to Human Sciences. Many of them propose a solution such as the use of projects and the collecting and processing of data.

Another event that has brought together many papers was the Brazilian Reading Congress (COLE) (Nacarato and Lopes, 2005) that focus on the relation between the Language and Mathematics Education. Sixteen research groups were created, three of them dealt with Masters and PhD degrees programs in Mathematics Education (UNICAMP, PUC-SP and UNESP) and one for Masters and PhD degree in Cognitive Psychology (UFPE).

UNICAMP (http://www.unicamp.br) houses two groups: Pedagogical Practice in Mathematics (PRAPEM) and the Psychology of Mathematics Education (PSIEM). The former has published 21 PhD theses and 24 Masters dissertations: two of the thesis and three of the dissertations are related to Statistics teaching. All these papers focus on Elementary and Secondary Education and teacher training. This group has published three books related to Statistics teaching aiming Elementary school teacher training. The latter has been working on the emotional aspects (attitudes towards Statistics) and cognitive aspects (Mathematical Abilities) on Statistics learning, through two PhD theses and a Masters dissertation. These papers were aimed at the University level and Statistics users. There is a thesis about the activities of the Statistics teacher at University level. UNICAMP publishes a magazine called *Zetetiké*, but it has not published any paper in this area up to now.

UNESP – Universidade do Estado de São Paulo, Rio Claro Campus, has produced three Masters dissertations. This program has no group linked to the area. Its program publishes the Bulletin of Mathematics Education (Bolema) (http://ns.rc.unesp.br/igce/matematica/bolema), only one article on the subject has been published.

At the Pontifícia Universidade Católica PUC-SP (http://www.pucsp.br) eleven Masters dissertation, related to Statistics teaching, have been presented, seven of them aiming Elementary and Secondary Education, working the PCN, information treatment, bars graphic, probabilities, aiming at teacher's training and the creation of concepts. The papers aiming at University level focus on the concept of probability or to the Statistics users training. The teachers are linked to the Study and Research Program on Mathematics Teaching (PROEM), which publishes the magazine *Educação Matemática Pesquisa* but it has not published any articles about the subject.

The Cognitive Psychology group of the Universidade Federal de Pernambuco - UFPE (http://www.ufpe.br/psicologia) has been working on the cognitive aspects involved in the making and interpretation of statistics graphics in Elementary and Secondary Education. They produced two PhD theses and a Masters dissertation.

Other groups that have been presenting papers in events are: Statistics Education from ULBRA; Mathematics Education from Pontifícia Universidade Católica do Rio Grande do Sul - PUC-RS, which has research in Statistics and Probability Teaching; Pontifícia Universidade Católica de Campinas PUC-Campinas (EPEMAT); Universidade Estadual de Santa Cruz – UESC Teaching and Learning Group of Mathematics with Computers (GPEMAC); Statistics Teaching at UNIMEP; GEST at UNIJUI; Statistics Teaching at UNESP-Marília; and Uncertainties Treatment and Adaptive Systems Laboratory (LISA) at UFSC.

Besides these groups, there are others but no papers related to this area has been found: *Estudos em Informática Educativa para o Ensino de Matemática* from PUC-MINAS; *Educação Matemática* from UNISANTA (Santa Cecília); *Informatica, Tecnologias e Educação Matemática* from URI; *Grupo de Pesquisa em Matemática* GPM from UNISA (Santo Amaro); Modelagem

Matemática da PUC – Campinas and the Núcleo para Desenvolvimento em Tecnologia e Ambiente Educacional from USP-Ribeirão Preto.

FINAL CONSIDERATIONS

The results show the increasing interest of researchers and teachers working on Statistics teaching, as well as the need for a research that answers various problems found in the Statistics teaching-learning process, mainly on Elementary and Secondary Education users training. It is expected that the 7th ICOTS consolidate the groups and create a permanent forum, to integrate the statistics educators, create opportunities, meetings, communication and publication of papers. It is necessary to make the community aware of the need that research results reach schools, because it is there where the scientific, critical and community spirit is formed and Statistics is a valuable instrument to citizenship.

REFERENCES

Alves, M. I. F., Montebello, M. I. de L, Lacerda, T. H. and Santore, M. O. C. (2004). Uma proposta para o ensino de Estatística nos cursos de Engenharia. *Livro de resumos do 16º SINAPE*.

Cazorla, I. M. (2002). *A relação entre a habilidade viso-pictórica e o domínio de conceitos estatísticos na leitura de gráficos*. Tese de doutorado. Campinas: UNICAMP.

Faggiani, A. (1994). *O comportamento acadêmico nos cursos de graduação da UNICAMP*. Campinas: Editora da UNICAMP.

Fernandez, D. and Selau, L. P. R. (1999). Cadeias de Markov aplicado ao curso de Estatística. *Anais da Conferência Internacional Experiências e perspectivas do Ensino de estatística: desafios para o século XXI*. Florianópolis - SC, 212.

Gonçalves, H. J. L. (2003). Educação Estatística: Apontamentos sobre a Estatística nos cursos de Pedagogia - Magistério para séries iniciais do ensino fundamental. Anais do IX Seminário IASI de Estatística Aplicada, Rio de Janeiro: IMPA.

Grácio, M. C. C. and Oliviera, E. F. T. (2005). O ensino de Estatística na UNESP/Campus de Marília. *Educação Matemática em Revista*, Ano 11, 17, 9-15.

MEC (1996). *Lei de Diretrizes e Bases da Educação Nacional*, Lei nº 9.394, de 20 de dezembro de 1996**,** http://www.presidencia.gov.br/ccivil_03/Leis/L9394.htm.

Mantovani, D. M. N. and Viana, A. B. N. (2004). Ensino de Estatística para cursos de graduação em Administração de Empresas - Novas Perspectivas. Trabalho Apresentado no VII Seminário de Administração FEA-USP, http://www.ead.fea.usp.br/Semead.

Nacarato, A. M and Lopes, C. A. E. (2005). *Escritas e Leituras na Educação Matemática*. Belo Horizonte: Autêntica.

Panaino, R. (1998). *Estatística no Ensino Fundamental: uma proposta de inclusão de conteúdos matemáticos.* Dissertação de Mestrado, UNESP, Rio Claro-SP.

Silva, C. B. da, Cazorla, I. M. and Brito, M. R. F. de. (1999). Concepções e atitudes em relação à Estatística. *Anais da Conferência Internacional Experiências e perspectivas do Ensino de estatística: desafios para o século XXI*. Florianópolis - SC, 18-29.

Wada, R. S. (1996). *Estatística e Ensino: um estudo sobre representações de professores de 3º grau.* Tese de doutorado, UNICAMP, Campinas – SP.

WEB REFERENCES

ABE (2005). www.redeabe.org.br

CAPES (2005). http://www1.capes.gov.br/Scripts/Avaliacao/MeDoReconhecidos/Area/GArea.asp.

MEC (1999). Diretrizes Curriculares para Cursos de Estatística. Brasília. http://www.mec.gov.br/sesu/ftp/curdiretriz/estatistica/esdire.rtf.

MEC (2005a). Parâmetros Curriculares Nacionais–PCNS, http://www.mec.gov.br/sef/relat/gestao.shtm.

MEC (2005b). Cadastro das Instituições de Educação Superior, http://www.educacaosuperior.inep.gov.br/.

SBEM (2005). http://www.sbem.com.br.

UFMG (2005). www.est.ufmg.br.

UFSC (1999). Anais da Conferência: http://www.inf.ufsc.br/cee/.

UNICAMP (2004). *Anuário Estatístico da UNICAMP.* http://www.aeplan.unicamp.br/anuario_estatistico_2004.