TRAJECTORY AND PROSPECTS OF STATISTICS EDUCATION IN BRAZIL

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This paper aims to present the trajectory and prospects of the movement for Statistics Education in Brazil from the historical-bibliographical research of the scientific production by 43 researchers belonging to the workgroup called GT12–Probability and Statistics Teaching. There is a growing trend in terms of quantity and quality of publications as well as advices for dissertation and thesis in post-graduate programs in Mathematical Education and related areas. However, this production is highly concentrated in twelve researchers, who were named as anchor researchers. Moreover, it is observed that the former advisees end up not working and not researching in this area. However, the outlook is promising, because GT12 is encouraged to expand collaborative and inter-institution research networks and has been promoting activities that boosted the movement.

INTRODUCTION

By the end of the 1990s, the concepts of Statistics were not dealt with in brazilian schools. With the publication of the National Curricular Parameters–PCN, these concepts began to be discussed by the educational and academic community, and have been officially incorporated into the curriculum structure of the subject of Mathematics in primary and secondary school (Brazil, 1997, 1998) and high school (Brazil, 2002, 2006).

In primary and secondary school, the contents of Statistics, Probability and Combinatorial Analysis are part of the "Information Handling" block, which is one of four content blocks of Mathematics ("Numbers and Operations", "Quantities and Measures" and "Space and Shape"). In the high school, they are part of "Data analysis", which is one of the three axes ("Algebra: numbers and functions" and "Geometry and Measures"). In addition, the procedures for data and information collecting, processing and interpretation are highlighted in the proposals for nearly all subjects, especially in Biology, Chemistry, Physics, and Geography, and in the work with crosscutting Themes.

PCN suggest that teachers encourage students to observe phenomena, conjecture hypotheses, collect data, handle and analyze them, from the standpoint of scientific research. They also encourage reading and interpreting graphs, tables, and measurements published by various media, so that students learn how to position themselves critically in view of such information, by providing them with tools for identifying information that is, perhaps, misleading or malicious.

The emphasis on Statistics and Probability given by PCN and the implementation of their contents in schools have generated a demand for research in Statistics Education, encouraging many researchers to study this subject.

These facts gave rise to two different streams of research in Statistics Education in Brazil. One of these is comprised by researchers linked to Mathematics Education and related areas, which has strong links with school and, mostly, are part of the undergraduate degrees in Mathematics and Pedagogy (Teacher Education) and/or postgraduate studies in Mathematics Education or related fields. In 2000, some of these researchers created a Workgroup within the Brazilian Society of Mathematics Education, known as GT12 - Probability and Statistics Teaching.

The other stream is formed by professors who teach Statistics to undergraduate and graduate courses in different fields of knowledge. Most of these researchers are more concerned about the formation of statisticians and users of Statistics in Higher Education, and they have stronger ties with the Brazilian Association of Statistics - ABE.

In this paper, to analyze the movement of Statistics Education in Brazil, we chose to draw the profile of the scientific production by 43 GT12 researchers, as it is a group

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institutionalized and representative of this movement. Thus, this paper aims to answer three questions: who are we?; where are we?; and what do we investigate?

METHOD

To draw the profile of the scientific production by 43 researchers from GT12 (30 PhDs, 11 Masters and 2 undergraduates), we carried out a historical-bibliographical research or a review, which according to Fiorentini and Lorenzato (2006, p. 71) "is the method of study that proposes to carry out historical analysis and/or review of studies or processes having as analysis material written documents and/or cultural productions prospected in archives and collections".

We considered as being *scientific production* all concluded papers in scientific conference proceedings, journal articles, books and book chapters published, as well as dissertation and thesis advices, both in progress and concluded, related to Statistics Education, which are reported by the researchers in their resumes at the Lattes[1] Platform (by Jan 21, 2010). Also included are dissertations and theses by researchers who developed their themes in the area.

To analyze the publications, we identified: the year of publication; name of the event or journal title or publisher of the book; methodological approach and the researched contents. To rate the methodological approach, we grouped into four categories: analysis of instrument (tests and scales), analysis of documents (textbooks, resumes); historical aspects; and teaching and learning process. The contents were categorized into: Combinatorial Analysis, Statistics only, Probability only, and the latter two simultaneously (Statistics and Probability).

The theses and dissertations whose advisors were GT12 PhD researchers have been accessed from the database of theses with the Coordination for Improvement of Higher Education Personnel (CAPES, 2010), from the portal of the post-graduate programs where they were defended, and, when they were not available on the Internet, they were asked for to the researcher.

The theses and dissertations were analyzed from reading their abstracts, in which we identified: type of paper (dissertation or thesis), year of presentation, institution, advisor, methodological approach, researched contents, and the educational level of participants in the surveys. For the approach and contents, we used the same categories of publications. To classify the educational level of those surveyed we created five categories: basic education students, higher education students, basic education teachers, higher education professors, and other professionals.

To analyze the ability to develop collaborative research within and between institutions we also verified the participation of these researchers in research groups registered in the Directory of Research Groups with Brazilian National Agency for Science and Technology (CNPq) using the keywords "Statistics Education" and "Statistics Teaching". In these groups, we investigated the lines of research and the researchers involved.

After all this survey, we identified research networks. We define a *research network* as the one formed by PhD researchers from at least two different institutions. Some researchers from these networks have been named anchor researchers, considering their capacity for scientific production, be it connected to advising in post-graduation programs or to relevant projects for the development of GT12.

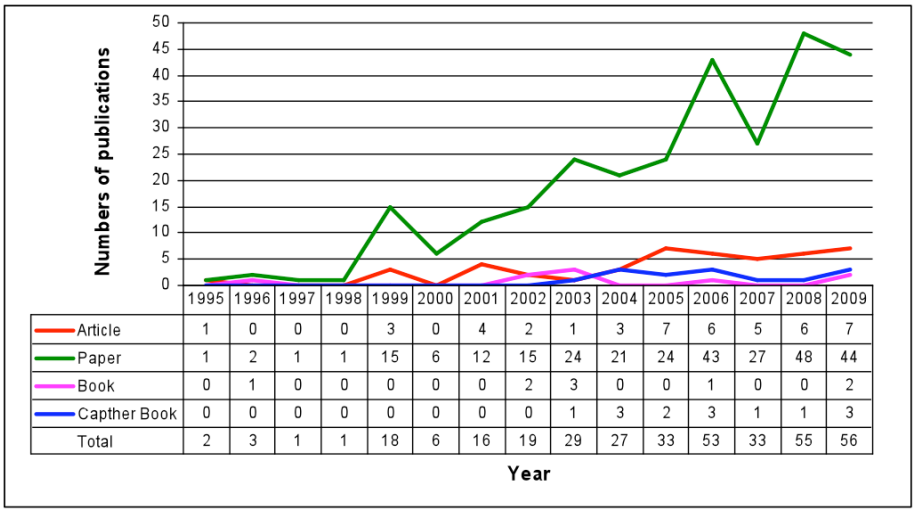
GT12 PRODUCTION

Publications

Taking into consideration the publications by the 43 researchers with GT12, congress proceedings, articles in journals, books and chapters, we observed a growing trend of production from 1995 until January 2010, with 352 publications, most of them (80.7%) in proceedings of scientific events (Figure 1).

By analyzing the surveyed contents, we observe that most publications concentrate in the area of Statistics (68.2%), followed by Probability (16.2%), Statistics and Probability (13.4%) and Combinatorial Analysis (2.2%). The methodological approach of most researches involves teaching-learning processes (81.5%).

The events with most papers presented were: International Seminar on Research in Mathematics Education (12.0%); Ibero-American Congress on Mathematics Education (7.7%), National Meeting on Mathematics Education (7.7%), Brazilian Meeting of Post-Graduation Students in Mathematics Education (6.7%), Sao Paulo State Meeting on Mathematics Education (6.0%) and International Conference on Teaching Statistics (5.0%).



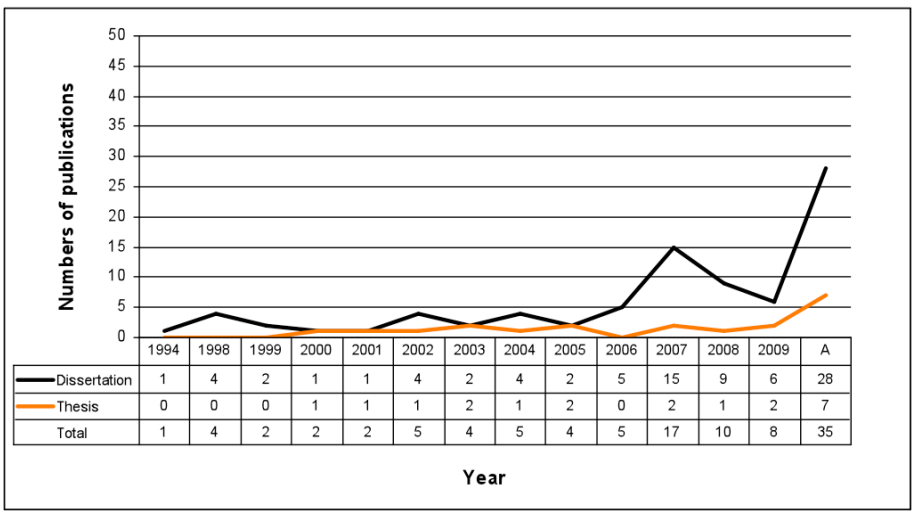
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Article	1	0	0	0	3	0	4	2	1	3	7	6	5	6	7
Paper	1	2	1	1	15	6	12	15	24	21	24	43	27	48	44
Book	0	1	0	0	0	0	0	2	3	0	0	1	0	0	2
Capther Book	0	0	0	0	0	0	0	0	1	3	2	3	1	1	3
Total	2	3	1	1	18	6	16	19	29	27	33	53	33	55	56

Figure 1. Publications by GT12 in the area of Statistics Education per year

Master's and PhD advices

Looking into the scientific production of GT12 researchers engaged in Postgraduate programs, regarding their advices to dissertations and theses, we noted that all of them are connected either to Master's and PhD programs in the area of Mathematics Education or in the area of Science and Mathematics Teaching or similar, concentrated in the state of Sao Paulo. A total of 56 dissertations and 9 theses have already been defended, and 28 dissertations and 7 theses are in progress (A) (Figure 2).

In the results of Figure 2, we included three dissertations (two in 1998 and one in 1999) and two theses (2002 and 2005) defended by GT12 researchers, in the area of Statistics Education, whose advisors were not part of the group.



	1994	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	A
Dissertation	1	4	2	1	1	4	2	4	2	5	15	9	6	28
Thesis	0	0	0	1	1	1	2	1	2	0	2	1	2	7
Total	1	4	2	2	2	5	4	5	4	5	17	10	8	35

Figure 2. Dissertations and theses by GT12 per year

Most dissertations and theses (78.5%) were defended in Master's and PhD Programs in: Mathematics Education at PUC-SP; Education at UNICAMP (area of concentration in Mathematics Education), Science and Mathematics Teaching at UNICSUL; and Mathematics Education at UNESP - Rio Claro.

Most dissertations and theses in progress (74.3%) are concentrated in Master's and PhD Programs in: Mathematics Education at PUC-SP; Mathematics Education at UNIBAN; and Science and Mathematics Teaching at UNICSUL.

Looking into the researched contents, most dissertations and theses deal with Statistics only (73.9%), followed by Probability only (13.1%), Statistics and Probability simultaneously (7.2%), and Combinatorial Analysis (5.8 %). In statistics, emphases are given to measurements of central tendency, graphs and tables. The methodological approach of most researches involves the processes of teaching and learning (88.4%), with emphasis on the processes of intervention. Some kind of software was used in only 13.0% of dissertations and theses. Of the participants involved in surveys, with regard to school level, we have: 40.3% were basic education students, 26.9% higher education students, 26.9% basic education teachers, 2.9% higher education professors, and 2.9% other professionals.

GT12 RESEARCH NETWORK AND ANCHOR RESEARCHERS

In total, there are eleven research groups connected to the area of Statistics Education in Brazil, involving 25 researchers from GT12. Four out of these groups are structured within a single institution of higher education, with three of these groups focused on a single researcher, and involving mainly the advisor/advisee relation. The other seven groups involve PhD researchers from at least two higher education institutions, in a relation of collaborative research development.

For mapping out the anchor researchers, we used as a first criterion the number of scientific productions. A descending ranking of scientific production was prepared, with the ten best-ranked researchers being considered anchor researchers.

In addition to the 10 researchers, another two researchers have been considered as anchors, one for his/her history of PhD thesis advised (production density) and the other for his/her production in journals, dissertation advices, and networked researches. Therefore, twelve anchor researchers have been identified.

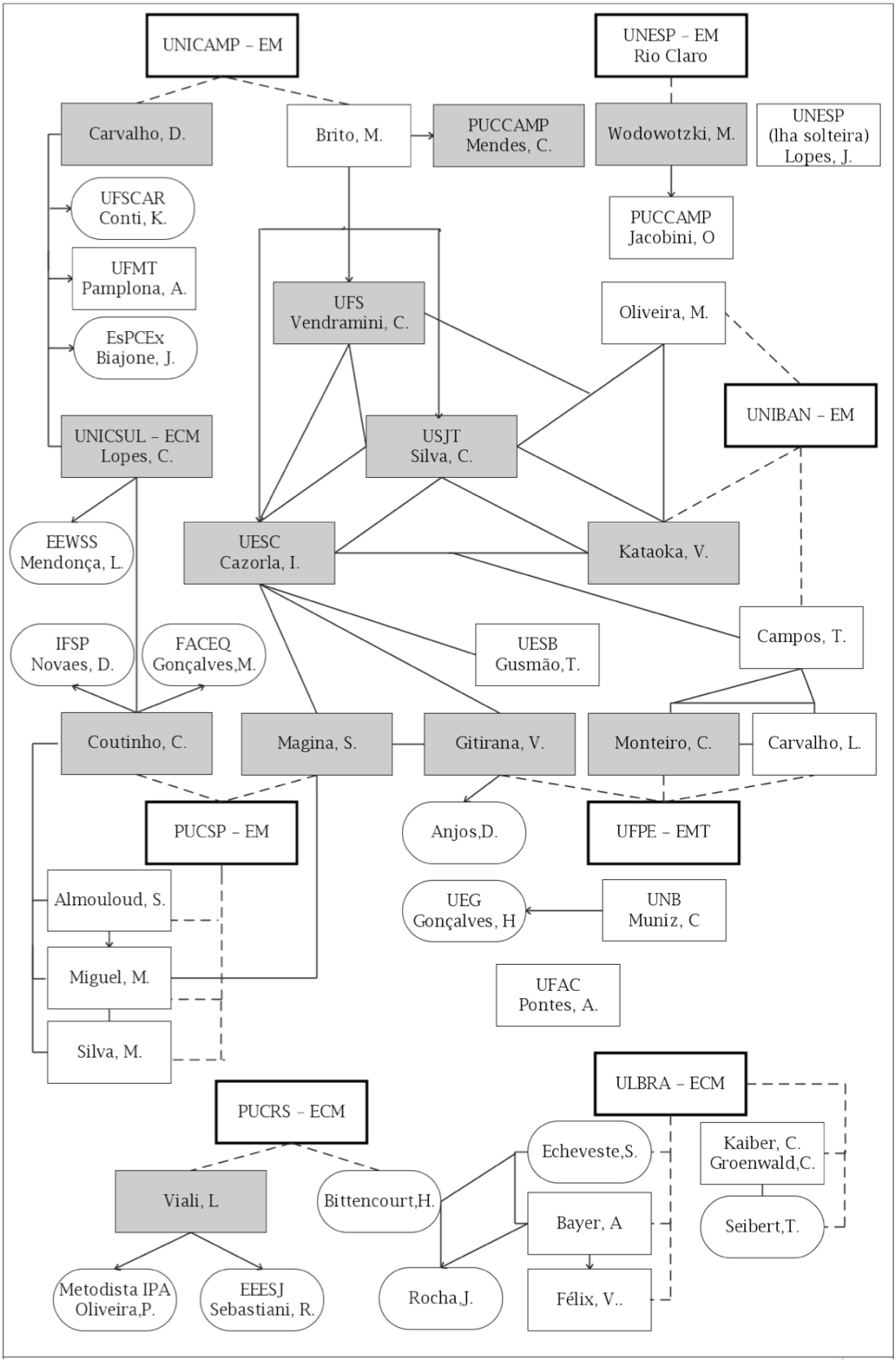
These researchers are responsible for 75% of the scientific productivity of GT12, for 100% of books and chapters of books; for 75.6% of journal articles; and for 68.4% of publications of papers in conference proceedings. They accounted also for 90.5% of the dissertation advices, and 75% of the thesis advices.

The scheme of Figure 3 shows how the 43 GT12 researchers are related. We observe four types of sub-networks. The first type of sub-network is formed by anchor researchers that relate primarily by developing collaborative work; the second is characterized by the advisor/advisee relationship; the third is a combination of the two previously mentioned types; and a fourth type consists of researchers who still work in an isolated way, without the partnership of other members of GT12.

The major topics investigated by this group are: teacher training, development of teaching sequences in different learning environments (classroom and computer), development and validation of tools involving affective and cognitive aspects of Statistics learning, analysis of documents and textbooks, mathematical modeling and its interfaces with Statistics. We found that most of the researches aim to develop and improve the level of statistical literacy of both students and teachers in different school levels.

FINAL CONSIDERATIONS

After 10 years of its establishment, GT12 has no grown substantially in terms of number of researchers, and still has a growing scientific output both in terms quantitative and qualitative (in the sense of using more consistent theoretical and methodological references) resulting from an increasing number of dissertation and thesis advices. However, this scientific production is highly concentrated. The twelve anchor researchers account for 75% of the GT12 production.



(Gray rectangle – anchor researchers; White rectangle – PhD researchers; Circles – Master's or undergraduate researchers; White rectangle with bold borders – higher education institutions with post-graduation programs; Arrow - relating adviser/oriented)

Figure 3. GT12 research network

The no-growth in the number of researchers is due to the absence of a process to multiply researchers, since most of the 65 former advisees were not incorporated into GT12 and are no longer involved in the research for Statistics Education; and due to the abandonment of the area by some researchers and no adherence by new ones, except as advisees.

We believe this is due to several factors, including the lack of the subject Statistics Didactics in teacher education courses (Pedagogy and Mathematics), as well as in Master's programs. Viali (2008) and Gonçalves (2003) show that most of these courses, in addition to having only one Probability (Degree in Mathematics) and Statistics (Pedagogy) subject, their teaching does not address aspects of statistics and probability didactics.

Among the positive aspects, we can mention a renewal in the stance of GT12, which is currently linking their members together to write a book about the research at GT12, plans to hold a meeting of researchers in 2011, and encourages the linkage of researchers in the development of collaborative work among institutions.

In this sense, we believe that Statistics Education in Brazil has prospects for growth and consolidation.

NOTE

1. In Brazil, all academic researchers must publish and keep updated resumes with the Lattes Platform (http://lattes.cnpq.br/), which became available online.

ACKNOWLEDGEMENT

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