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The National Advisory Committee on Statistics, though not an accrediting body has in the past had a say in providing some form of guide B.Sc. syllabus to be used in Nigerian Universities. Nothing in its terms of reference prevents it from still playing some more effective role.

The practice of the use of external examiners by the Universities is one helpful way of at least preventing absurdities in the standards.

It is worth mentioning that the issue of curriculum and related matters is currently being examined by the Federal Government.

7.9 THE TASK

From an ongoing survey of Training Institutions in the country, it seems that the problems in the production of practically oriented statisticians lie in the needs for appropriately qualified staff, teaching materials (books etc.) especially in the specialised applied socio-economic areas and computing facilities to mention a few.

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CHAPTER 8

The Training of Statisticians in Argentina

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8.1 INTRODUCTION: THE ARGENTINE EDUCATIONAL SYSTEM

Argentina is a republic ruled by a federal system of government, divided into 22 provinces, 1 territory and the capital (the city of Buenos Aires), and with a current population estimated at nearly 30 million inhabitants. The basic principles of education in the country were established in 1884 by law No. 1420, in which the Federal Council of Education was established.

Education is divided into the primary, secondary, tertiary and university levels. Public primary and secondary schools belong to federal and provincial systems, as well as to some local governments, and public universities belong to a federal system. All of them are free for the students. At each level there also exist private educational institutions. Table 1 shows total enrolment in 1984, and percentages corresponding to the public sector.

Primary education is compulsory for all children between 6 and 14 years of age. The standard program lasts seven years, and is aimed at 'stimulating and guiding the intellectual, physical and behavioral development of children' in those ages. In some provinces the first three years have a system of automatic promotion. In rural areas special programs are offered. There also exists a program of 'adult education' devoted to persons with ages exceeding those of the primary school level.

Secondary education is implemented with different objectives in view, and the duration of the studies (typically between 4 and 6 years) varies depending upon these objectives. Basically there are the following types of secondary schools: humanistic, commercial, agronomic, technical, artistic, biological, and others.

Tertiary education prepares teachers and professors: the former are accredited to teach in primary schools, the latter to do so in secondary schools.

There is a total of 52 universities operating in Argentina in 1985. Table 2 shows total enrolment in 1984, and total number of diplomas granted in 1979 by the 8 largest public universities.

Universities are usually divided into 'facultades' (schools) whose main responsibility is to conduct the teaching programs in related areas. For example, in 1984 the University of Buenos Aires consisted of the following schools, with percentages of total enrolment: Economics and

Table 1 Total enrolment in the Argentine educational system, 1984

Level	Enrolment (thousands)	Public (%)
Primary	4,430.5	81
Secondary	1,562.3	70
Tertiary	169.5	77
University	508.0	84
Total	6,670.3	78

Source: Ministerio de Cultura y Educación (1984b)

Table 2 Total enrolment in 1984, and diplomas granted in 1979, in Argentina's eight largest public universities

University	Enrolment, 1984 (thousands)	Diplomas, 1979 (thousands)
Buenos Aires	149.1	9.7
Córdoba	49.9	4.4
La Plata	34.1	3.1
Nordeste	25.7	2.2
Tucumán	19.8	1.0
Rosario	18.1	1.8
Litoral	11.7	0.8
Cuyo	11.4	0.5
Totals	319.8	23.5

Source: Ministerio de Cultura y Educación (1979), (1984a)

Administration (20.9%), Law (19.3%), Medicine (9.9%) and Dentistry (2.3%), Humanities (8.6%), Engineering (8.5%), Architecture (7.6%), Mathematics, Physics and Natural Sciences (6.0%), Agronomy (3.5%) and Veterinary (3.0%), Biochemistry and Pharmacology (2.8%), and other programs (7.6%).

In several universities some schools have organised programs at a graduate level, but on the whole there does not exist a regular organised system for this kind of studies. Standard university careers are theoretically 5, 6 or 7 years long, but it actually takes most students 8 or more years to graduate.

8.2 APPROACH FOLLOWED IN THIS PRESENTATION

Education and training of statisticians at professional and semi-professional levels is offered in Argentina at several different places. Universities have undergraduate and graduate programs, some in collaboration with other institutions, while in-house training in statistics is given in some

agencies. We will describe five programs that we regard as the most important ones considering their size or type of work done.

For these programs we have some relevant statistical information, for example about their human resources. There are (and there have been) other programs, but they are either very small or unstable in their operations.

The indicated five programs are the graduate-level programs at INTA (Castelar, Buenos Aires) and at the University of Tucumán, the doctoral program in mathematics at the University of Buenos Aires, the undergraduate program at the University of Rosario, and the in-house training program at the National Institute of Statistics. The corresponding institutions are financially supported by the federal government.

8.3 THE MASTER'S PROGRAMS IN BIOMETRY AT INTA

INTA (National Institute for Agricultural Technology) is a federal-supported government agency that operates a network of 44 agricultural stations throughout the country. In Castelar, near Buenos Aires, a central Department of Statistics is located, that since 1980 has been giving series of courses to train young graduates in statistical theory and methods.

This structure was used as a base for the organisation of a master's ('Magister Scientiae') program in Biometry, which is part of a cooperative agreement of INTA with the School of Agronomy, University of Buenos Aires, and is carried out at Castelar. The program aims at giving graduate-level training in statistics to biologists, mathematicians and statisticians, with emphasis on biological applications demanding a great deal of statistical methodology.

The idea of training groups of persons coming from different university backgrounds is based on the following main principles: (a) For statistics to have its proper role in a given area of research, it is necessary to have subject-matter specialists that also have a sound competence in statistics; (b) Interdisciplinary groups provide fruitful environments for the learning process, in particular for statistics at graduate level.

Admission requirements for the master's program include a university degree and passing an examination in the English language. Applicants must show promise to satisfactorily pursue advanced studies in biometry (e.g. by being adequately prepared for such studies) and be clearly motivated for the program that is attempted.

Enrolled students develop individual programs of study in consultation with advisory committees. Requirements include a set of courses and the preparation of a thesis report.

Courses offered are sequences in statistical methods, statistical theory, and experimental design, plus courses in regression analysis, linear models, multivariate analysis, and sampling. There are further courses in uses of statistical computer programs, advanced topics in biometry, and consulting. Background courses in mathematical analysis and linear algebra are also offered.

8.4 THE GRADUATE PROGRAMS AT THE UNIVERSITY OF TUCUMÁN

Graduate teaching programs in applied statistics have been conducted since 1973 by the INIE, Institute of Statistics, School of Economics and Administration, University of Tucumán. The research projects of this institute receive support from the Argentine Research Council (CONICET), that since 1983 has also helped the indicated teaching programs.

Two programs have been designed each lasting one academic year. The first-year program (EPEA) was offered in 1973, 1975, 1983, 1984 and 1985; the second-year program (CSEA) was offered in 1974, 1976, 1978 and 1986. They are open to university graduates with any type of background, although they must have clear quantitative interests and abilities. The programs are separated, in the sense that students can take the first, both, or only the second-year program if they have acquired the needed background elsewhere. Certificates of completion are awarded by the university. The two programs are intended to correspond to a master's degree in applied statistics, and starting in 1986 the granting of such a degree will be considered by the University of Tucumán.

The objectives are to offer intensive programs of studies and practical work, so that graduates working in centers devoted to various subject-matter areas are trained for the effective use of modern statistical methods. The programs are not oriented to the preparation of university teachers of statistics, but after completion some participants have pursued further studies to this purpose.

The first-year program includes a basic sequence of courses in statistical description and inference, and courses in probability, elements of mathematical statistics, regression and econometrics, introductions to sampling and experimental design, demography and operations research; courses in college mathematics, calculus and advanced calculus are given for those in need of them, and a course in computer programming is required of all participants. The first-year curriculum is flexible, depending on the participant's abilities and interests.

The second year includes introductions to mathematical statistics, multivariate analysis, time series, and simultaneous equations in econometrics; a course in the use of computers for statistics is given, and topics are provided for individual projects. The students have easy access to a small computer in the institute, or may process data in the university's computer center, where the institute keeps several standard statistical packages.

In 1983, 1984 and 1985 a total of 47 full-time students participated. Fellowships for Argentine graduates were provided by CONICET and by other similar institutions, or individuals were financed by their own employers. In 1984 and 1985 a total of 11 Latin American graduates from outside Argentina participated, 10 of them sponsored by the Organisation of American States. Most frequent backgrounds of participants were in mathematics, economics and agriculture, but graduates from engineering, sociology, psychology and other fields also attended.

8.5 THE DOCTORAL PROGRAM IN MATHEMATICS AT THE UNIVERSITY OF BUENOS AIRES

In the School of Mathematics, Physics and Natural Sciences of the University of Buenos Aires, the Department of Mathematics has organised a Statistical Laboratory in recent years. In this laboratory advanced training and guidance for research in statistics is provided. Recipients of the first degree of 'Licenciado' in Mathematics offered by the department (a 5-year program), may consider specialising in statistics and eventually obtaining a doctoral degree in mathematics with a dissertation in the statistical field.

This program has been small in terms of the number of participating students: 3 doctorates were granted in the last decade, and a reduced number of graduates is currently enrolled. However, standards have been set high in terms of the expected quality of the participants and of the research to be done.

At present, a project is being developed by the Statistical Laboratory to organise a 5-year program leading to the degree of 'Licenciado' in Statistics. After approximately two initial years of courses in common with students of applied mathematics, those in the new program will intensify the coverage of statistics and related subjects. Graduates from the doctoral program described above will be the principal source of teaching staff for the new program.

8.6 THE UNDERGRADUATE PROGRAM AT THE UNIVERSITY OF ROSARIO

In the University of Rosario (formerly a part of the 'Universidad del Litoral'), the School of Economics and Administration includes a Department of Statistics that offers a first degree in Statistics. The teaching program currently takes 5 years, and is the largest such program in the country, the oldest one in Argentina, and one of the oldest in Latin America.

The teaching program was established in 1948 as a three-year undergraduate program oriented to official, administrative and economic applications of statistics. It was an outgrowth of the pioneering effort of a small group of statisticians, initiated in 1927 under the leadership of the late Professor Carlos E. Dieulefait. The contents, length, and orientation of the program changed several times, with major revisions taking place in 1957, 1966, 1976 and 1985.

Table 3 contains quantitative information about the program: total enrolment, new entering students, and graduates. The program had by 1978 produced 600 graduates in statistics.

In the beginning years of its operation, the program had an important positive effect on the development of statistics in Argentina (and even in Latin America), through activities developed by its graduates. In Table 4 we shall see that the situation of the program in 1980 (and for the most

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Table 3 Undergraduate Program in Statistics, University of Rosario, 1959-1983

Years	Total enrolment per year (rounded averages)	New entering students per year	Graduates per year
1959-1963	218	-	-
1964-1968	410	-	62**
1969-1973	368	103	41
1974-1978	331	89*	25
1979-1983	199	52*	14***

- Not available

* Since 1977 admission limited to (approximately) 50 new students per year

** Corresponds to 1968

*** Average of 4 years, 1981 not available

part it has remained unchanged until the present) was not promising, since very few members of the teaching staff had full-time dedication to the institution, or advanced training in statistics. Efforts are under way to reverse this situation. Part of the problem may be the insertion of the program in the School of Economics and Administration, where it has to compete for students and prospective staff members with standard and well-established professional careers in accounting, administration and economics.

8.7 STATISTICAL INFORMATION ABOUT THE CENTERS

For the 4 programs described so far, we have available some statistical information, coming from a survey of Latin American centers conducted in 1980. Table 4 summarises some of this information.

8.8 FELLOWSHIPS FOR GRADUATE WORK

Support for advanced training in sciences and technologies is provided by some national or provincial fellowship and research systems. National systems are those of the Argentine Research Council (CONICET) and the Institute for Agricultural Technology (INTA), while a provincial system is that of the Buenos Aires Research Commission (CIC). We will describe briefly the program of CONICET, which is typical.

Admission to the fellowship program is opened every year, and is restricted to university graduates. Recipients start programs that may last 2, 4 or even 6 years; each individual project is organised on a research topic, to be developed in a well-established center under a research director. During the indicated time periods the fellows take recommended

THE TRAINING OF STATISTICIANS IN ARGENTINA

Table 4 Some Indicators on Personnel and Production of the Four Selected Teaching Programs

	INTA, Castelar	Tucumán	Buenos Aires	Rosario
<i>Personnel, 1980</i>				
1. Total	9	18	14	72
2. Postgraduate degrees: doctorates and masters	3	7	2	3
3. Id. in statistics, mathematics, computation, operations research	3	4	2	2
4. Postgraduate degrees from USA, Europe, etc.	2	5	1	-
5. Id. in statistics, mathematics, computation, operations research	2	3	1	-
6. Id. in statistics	2	3	1	-
7. Full-time dedication to the center	9	9	6	2
<i>Publications, 1977-79</i>				
8. Foreign or international	2	5	5	2

Source: Mentz and Jarma de Cortés (1981)

courses and seminars, and perform their research activities. Every two years they are evaluated, and those satisfactorily completing their programs are entitled to start as junior researchers, still operating under supervision. An objective is to reach the level of 'independent researcher' in the corresponding field. The program is fully compatible with work towards a higher degree in Argentine universities, or with programs of study or research abroad.

These programs have been used for advanced training in statistics. For example, the three graduate-level programs described above use these fellowship programs as means of recruiting young graduates for their own staff, or to be trained for other institutions.

8.9 THE ARGENTINE STATISTICAL SYSTEM AND INDEC

The National Institute of Statistics (INDEC) located in Buenos Aires, is the main governmental statistical office, and heads the Argentine Statistical System. In recent years INDEC has organised an active in-house program of courses, seminars, workshops and the like. Some of them are devoted to university graduates, others to non-graduate technical personnel; some are general, organised about some statistical topics or types of applications, while others are concerned with particular needs of the statistical offices.

An elementary course in descriptive statistics has been offered several times since 1981, in Buenos Aires and in four other cities. The overall

program developed in recent years includes 7 different courses that are repeated or planned to be repeated periodically, and a collection of other ad-hoc activities.

The organisation and implementation of these activities is very timely, in view of past experiences of the Argentine Statistical System. Information available for 1978-79 showed the following points: (1) The overall percentage of university graduates among INDEC employees was low (11%) in relation to comparable groups of government agents; (2) Even for medium and high-level technical personnel the percentage of university graduates in INDEC was low, less than 40%; (3) Among medium and high-level technical personnel of INDEC (and more so in other statistical agencies) more than 50% had not participated in in-house training activities; for example, less than 40% had participated in any kind of training in the field of computers.

Preliminary information about personnel in the Argentine Statistical System as a whole, as for April 1984, was recently made public: a total of 3,615 persons were then employed, of which 19% had completed university-level studies of any kind.

8.10 STATISTICIANS AT WORK

Having dealt with the most important programs of teaching and training of statisticians in Argentina, we will now consider some of the main fields in which statisticians work.

Official Statistics. As indicated in Section 8.9, the Argentine Statistical System has around 700 university graduates, of which some have degrees in statistics. The system has a total of about 1,150 employees that have received some university-level education.

Academic. Table 4 of Section 8.7 contains some information about persons employed in teaching at undergraduate and graduate levels, and doing research in statistics. We should also consider those teaching statistics in various subject-matter areas. The 52 Argentine universities have various undergraduate programs, many of which offer courses in statistics. A survey conducted in 1982 among universities in the Buenos Aires metropolitan area concluded: 'More than 60% of the students enrolled in undergraduate programs take courses in statistics, and the distribution is uneven among disciplines. The percentage increases slightly in the more important careers (5 or more years long). Important deficits (even when the corresponding numbers of students are not large) are in medicine and architecture'. (Hulsberg (1984)).

Statistical services in government institutions. Under this heading we include those working as statisticians in government agencies devoted to work in various fields. Examples are the network of 44 agricultural stations of INTA (cf. Section 8.3), and the network of 203 research centers in various disciplines receiving direct support from CONICET (cf.

Section 8.8). Employment of statisticians in these and other networks is comparatively low. It may well be that INTA is the best staffed, with 22 statisticians working in various capacities.

Private services and consulting. Very little information is available on this area. There are statisticians working in marketing research, surveys of public opinion, and similar fields, in the Buenos Aires metropolitan area. However, it is very difficult to assess the number of persons involved and the kind of training they have.

8.11 ROLE OF THE ARGENTINE STATISTICAL SOCIETY

As a complement to formal education and training, an important contribution to updating is made by the Argentine Statistical Society. Organised in 1952 it had periods of low level of activity, but recent years have witnessed a great deal of interest in the programmed activities. Thirteen national statistical meetings have been held since 1952; the last three in 1983, 1984 and 1985 included the publication of the proceedings by the host institutions. The society started the publication of technical notes on various methodological topics, that are distributed to the members. Total membership was in the order of 300 persons some years ago.

The 43rd. Session of the International Statistical Institute was held in Buenos Aires in 1981, and a total of 349 Argentine participants registered. A symposium of international level held in 1976 in Buenos Aires was attended by more than 200 persons; see Lunde and Hunter (1981).

8.12 RESEARCH ACTIVITY AND PUBLICATIONS

A brief comment should be devoted to publications, as a possible measure of research activity in statistics. Mentz and Jarra de Cortés (1981) reported a total of 26 publications by Argentine statisticians listed in the *Current Index to Statistics* for the five years 1975-79. This turned out to be as good an experience as that of any other Latin American country for that period. This can be taken (with care) as an indicator of the quantity and quality of the research done in the country. See the indicated paper for further analysis of this material.

8.13 DISCUSSION, SUMMARY AND CONCLUSIONS

In this work we have described some current aspects of the training of statisticians in Argentina.

The undergraduate program in statistics at the University of Rosario is the largest and oldest in the country. It operates within the School of Economics and Administration, an arrangement that is frequently encountered in Latin America. This program is facing (and trying to solve)

difficulties in terms of recruiting good students and training them adequately.

At undergraduate level, but on a considerably smaller scale, we also have the activities of some programs in mathematics. Those that have well-trained professors of probability and statistics tend to give to mathematics students guidance in the direction of statistics.

Graduate programs with rather well-defined objectives are those of INTA at Castelar and the universities of Tucumán and Buenos Aires. The first two work at the master's level in statistics, the last one at the doctoral level in mathematics. These programs are small in terms of the sizes of their teaching and research staffs. In fact, there is no program in Argentina in which 5 to 10 professors and researchers in statistics work together. The existing programs are comparatively new and one may wonder about their future growth.

The present writers have suggested (Mentz and Sonvico (1983)) that a strategy for Argentina should rest on the improvement of existing graduate programs and the organisation of new ones. It would be important for the country to have at least 3 or 4 centers offering master's programs in statistics. They could have different orientations, for example they could emphasise mathematical statistics, general applied statistics, official and social statistics, agricultural and biological applications, business and industrial statistics, or others. Each center should have at least 5 to 10 full-time professors, as many of them as possible with doctorates in statistics or related areas. The centers should teach statistics in a context in which research, consulting and the dissemination of statistical ideas are given high priorities. They should have good specialised libraries, computer hardware and software, and active programs of national and international relations to keep the centers up to date.

The initial staffs of these programs should for the most part be trained abroad, in agreement with what has been the experience until now. Graduates from these programs should enter the official statistics sector, subject-matter teams working in various areas, business and industry, and other fields; to these fields they should bring new and working ideas about the use of modern statistical methods.

As the state of affairs improves, several objectives will tend to be achieved: a) Better-qualified teachers will offer the regular statistics courses in various subject-matter university programs; b) The organisation of undergraduate programs in statistics will be discussed adequately; c) Doctoral programs in statistics will be in a position to be organised; d) Efforts could be initiated to develop the teaching of statistics in secondary schools.

The speed with which the centers are organised, their rates of growth, and the sizes they eventually reach, will depend upon the effective demand for statistical services from various sectors, as indicated above. Experience so far has been rather encouraging, and recognition of the role of statistics in the Argentine society has been improving over time. Hence, we can expect with moderate optimism that some of the stated objectives will tend to be accomplished in the near future.

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