MENTORING STATISTICIANS IN FORMAL DEGREE PROGRAMS: THE MASTERS IN BIOSTATISTICS AT THE UNIVERSIDAD DE CHILE (1983-2005), ENTERING THE 21ST CENTURY

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This paper describes the process of renewal of the Masters in Biostatistics program according to the technologic, occupational and academic new realities present at the beginning of this century in a developing country. In 1983 the University of Chile created an academic program of Masters in Biostatistics oriented toward preparing highly qualified personnel in Biostatistics to perform university teaching functions, as well as research consulting in the biological and medical sciences. In 2002, the Masters in Biostatistics program underwent a re-engineering process that is reflected in changes in the lecture series, including revision of course content, requiring students to work real-life problems from the beginning of their degree program, introduction of computer simulation as a teaching and research tool, and discussion of both parametric and non-parametric inference procedures.

INTRODUCTION

This paper describes the process of renewal of the Masters in Biostatistics program according to the technologic, occupational and academic new realities present at the beginning of this century in a developing country. The Universidad de Chile is the oldest and the most important institution of higher education in Chile, with outstanding research in science, technology and humanities. In 2004 it was included in the list of the 400 best universities of the world (http://www.u-noticias.cl/downloads2/septiembre.pdf).

As part of the Faculty of Medicine of the Universidad de Chile, the School of Public Health (www.saludpublica.uchile.cl) has been conscious, since its beginning, of the usefulness and importance of the discipline of statistics in biological and medical studies. This includes the development of Chilean and Latin-American health systems, the inclusion of technology at all levels of health attention, and the growing demand of consulting for many organizations and researchers in the epidemiological and clinical areas. For these reasons it created, in 1983, the academic program of Masters in Biostatistics (University Decree Nº 00999 of March 15, 1983) oriented to prepare personnel highly qualified in Biostatistics to perform university teaching functions, as well as research consulting in the biological and medical sciences.

MATERIALS

To create (1983) the Masters in Biostatistics program the School of Public Health considered the previous experience gained from mid 60's to 1973 with another graduate program named Licenciatura en Bioestadística. Furthermore the School had an academic staff qualified in all the necessary areas, enough to successfully develop such initiative and national and international inquiries showed a generalized need for well trained professionals able to fulfil the biostatistics demands both in the academic (teaching, research and consulting) as well as in the health services.

To accomplish their objectives this program convene as scholars professional from the quantitative area as well professionals from the biological area, trying to the develop a professional interface. Several national and international finantial sources have provided fellowships for Chilean and foreign students.

The original organization of the Masters in Biostatistics included a year-long period of lectures divided in three cycles: basic, advanced and specialized, followed by a Thesis writing period. The courses in these cycles were taken from different areas such as Public Health, Mathematics, Computation and Statistics, with appropriate contents to achieve the central purpose of training a well-prepared specialist to apply statistics in biological and clinical work, while at the same time he/she remained autonomous in the continuing apprenticeship of his/her profession/science.

In 2002, the Masters in Biostatistics program underwent a re-engineering process that is reflected in the change of the lecturing period to three semesters followed by the thesis writing and, specially, in the revision of the course's contents. In 2003, the School of Public Health also created a doctoral program of Public Health and began the reformulation of the Masters of Public Health program.

The explosive development of computation and the technological progress that the country experienced during the last two decades permitted the switch from a university computation system based on two big central computers to a system composed of local servers and numerous personal computers. This situation allows students to work at real-life problems right from the beginning of their degree program moving from a classical scheme of Descriptive Statistics to dynamic Exploratory Data Analysis that generates ideas to be formalized later on other courses of the program, thus providing the global vision of their sustaining academic proposal. Additionally, whenever it is possible, courses include computer simulation as a teaching or research tool.

The course on Statistical Inference was scheduled around problem-solving situations, discussing parametric and non-parametric analytic alternatives. This change points to fix in the student the idea of a strategy of statistical analysis in three stages:

a) Formulate the research question (WHAT interested to the consultant?),

b) Formulate a statistical hypothesis and design the research (HOW could the researcher generate the necessary information to respond to his/her question (statistically translated)? And

c) Select a statistical method paying attention to (a) and (b) (WHICH statistical method responds to the research question that we received, keeping properly in mind the formulated hypothesis and the particular design adopted by the researcher.

The third core course of the Magíster in Biostatistics is Lineal Models. After studying the classic models of lineal regression, the linearizable and nonlinear models are discussed. Also logistic models are briefly described as a preview of the course on Analysis of Categorical Data. More sophisticated recursive models such as CART and MARS are announced to be studied in the course of Multivariate Methods. All these topics are worked through real applications, mostly from our own experiences as statistical consultants.

The study plan of this program includes a few required courses plus elective courses totaling 90 credits, the thesis writing is 40 credits worthy. Each student may choose their elective courses from other graduate programs offer by the School of Public Health, the Faculty of Medicine or other Universidad de Chile faculties, under approval of his/her adviser. Some courses of the International Summer School that the School of Public Health offers yearly are also creditable to the Masters of Biostatistics. In Table 3 we present the plan most frequently chosen by our students. Anyway the backbone of any student plan is the sequence *Exploratory Data Analysis, Statistical Inference and Linear Models*.

Table 1: Masters in Biostatistics program courses

Semester	Course
I	Exploratory Data Analysis*
	Calculus
	Probability Calculus*
	Introduction to Public Health
	Epidemiology I
II	Statistical Inference*
	Linear Algebra
	Statistical Computation*
	Sampling Techniques
	Epidemiology II
	Demography I
	Categorical Data Analysis*
III	Linear Models*
	Multivariate Methods*
	Survival Analysis
	Time Series Analysis
	Demography II
IV	Thesis writing

Required course

The program provides pursuit to students during the period of preparation of the thesis by means of the candidate's interviews with some of the three professors that conform his/her Committee of Thesis; this is developed mainly face to face, but for the candidates non residents in Santiago, apart from the regular mail, it is used intensively the electronic mail and all the possibilities offered by Internet. Recently, a candidate that had to visit United States for one year returned with her thesis finished thanks to phone conferences via Internet with her tutor and to the execution of her computational processes, that required to use some ad-hoc software, directly in our local server.

We expect to increase the graduation rate by combining several mechanisms: (a) during his/her thesis work the student not only receives support from his/her tutor, but also from the other professors of his/her thesis committee, (b) thesis progress reports must be presented as seminars to the staff Department (c) improved registrar control on graduation timing has been implemented and (d) almost all the present students are people that continue working part-time at some company (university, hospital, fisheries, etc).

RESULTS

In 2004, the Masters in Biostatistics program was accredited by the "National Commission for Quality Evaluation of Graduate Programs" (CONAP), an advisory body to the Chilean Government in universities' accreditation matters (http://www.conicyt.cl/becas/acreditacion-conap.html).

In Table 2 we summarize information about the nationality of our students: one third of them are Latin-Americans other than Chileans, mostly from Colombia, Argentina, Peru's, Brasil, Nicaragua and Panama.

Table 2: Students' precedence, 1983-2005

Country	Total	Percent (%)
Spain	1	0.6
Central Am. Caribe	14	8.2
South- America	38	22.2
Chile	118	69.0
Total	171	100.0

The main goal of the program: is to develop a graduate student competent to teaching and consulting in the interface between mathematical and biological efforts to generate knowledge. The dissertation titles of more than 80 graduates attests to the fulfillment of such goal, resulting many of them in theoretical or applied papers published in specialized journals. Table 3 contains a sample of titles.

Table 3: Recent theses in the Masters in Biostatistics Program

74	Algunas técnicas de manejo de valores faltante en un modelo de regresión log.
75	Estudio de sobrevida en pacientes operados por cá gástrico. Una aplicación del modelo de Cox.
76	Evalución de la precisión del diagnóstico de edad gestacional fetal basado en los datos de la mujer.
77	Estimación de coberturas de vacunación y estudio de factores asociados al estado vacunal en menores de cinco años en la ciudad de Pereira, Colombia
78	Sobrevida de los pacientes operados por cáncer gástrico
79	Cáncer vesicular en Chile. Un estudio de casos y controles pareados. Aplicación del modelo de regresión logística condicional.
80	Predicción de problemas de conductas en escolares del 6º básico, de la comuna Occidente de Santiago, Chile. Aplicación de modelos de regresión logística
81	Predicción de calidad del aire para material particulado PM10 en la estación Pudahuel de la red de monitoreo MACAM-2, comparación de dos modelos predictivos.
82	Comparación de la Dócima de Log-Rank con la Dócima F. de Cox en curvas de sobrevida provenientes de las distribuciones exponencial y de Weibull
83	Tasas de mortalidad por riesgo laboral de trabajadores asegurados en el INP Julio 2000 - Junio 2003

From a total number of 171 enrolled students, 158 have completed their corresponding course work and from these 83 are already graduated; i.e., the program has a 7.6% desertion rate and a 52.5% graduation rate.

Recently the Masters in Biostatistics program concentrated all the lecturing activities in to full days per week; this change has increased the number of postulants since it allows some of them to keep some part time job. On the other hand, we are appointing a three-member committee to assist each student working in his/her thesis and requiring an early progress examination of such work: we forecast an increased graduation rate.