COMPARATIVE STUDY ON TEACHING STATISTICS IN MATHEMATICS AND NON MATHEMATICS COLLEGES IN SANTA FE (ARGENTINA)

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We seek to carry out a comparison of the diverse characteristics that are presented in the teaching and learning of Statistics in different careers. We will compare the Statistics curriculum that are developed in each degree program, the objectives that are pursued, the different didactic methods that are used in each case, the applications used, the work with computer and other simulation instruments and the types of problems that receive larger emphasis in each discipline. From the student's point of view, we are carrying out an investigation that is in a first exploratory phase which will help us to describe the prior knowledge that the students bring when beginning their first statistic course, in connection with the intuitive interpretation of simple statistical graphics, such as graphics of bars and sectors, and interpretation of charts of frequencies.

INTRODUCTION

Actually, in the Argentinean University teaching, the Statistic is a subject that is dictated in careers of different characteristic such as Engineering, Economy, Medicine, Mathematics, as well as in careers related with the Social Sciences.

In all them an introductory course of Statistic is given in those that basic concepts of Descriptive Statistic and Exploratory Analysis of Data are developed and in most they are also developed basic concepts of Statistical inference. According to the character of the speciality, in some cases, a second course of Statistic is added in the one that more advanced concepts are developed and the use of the computer is added. A characteristic common of these careers, is that one has a great number of students that they fail an and another time in its exams of Statistic, for it is it our desire to find new forms of teaching the subject in such a way that this serves the student, really, like a tool to interpret the information of its discipline in an appropriate way.

In this work, we seek to carry out a comparison and description of the similarities and differences that exist in the diverse curricula of introductory Statistic, which will allow us to analyze in a critical way the implementation problems in these programs. The objective of this analysis will be to carry out a revision and improvement of the programs in the careers of: Faculty in Mathematics, Faculty in Biology, Degree in Biodiversity, Degree in Geography, Degree in Sociology, Degree in Psychology and Degree in History. These careers are dictated in two different Universities, a state one and another private one: *Universidad Nacional del Litoral* and *Universidad Católica de Santa Fe.*

DIFFERENCES AND LIKENESS IN THE PROGRAMS OF STATISTIC IN UNIVERSITY CAREERS

In this section we will analyze the programs of Statistic of the careers mentioned in the previous paragraph, which will be contained in the following way: *Group 1*: Faculty of Mathematics. *Group 2*: Degree in Psychology. *Group 3*: Faculty of Biology and Degree in Biodiversity. *Group 4*: Degree in Geography, Degree in History and Degree in Sociology.

In the Table 1 are presented the quantity of weekly hours in each subject and the subjects related with Statistic that are dictated in each career or groups of careers. As you can there is disparity as for the quantity of hours in those matters that are dictated and in the developed contents. Let us see some differences:

In the careers of the Group 1 and 2, two subjects are given, in two quarter, which add 12 weekly hours but they differ in the worked contents. In the Group 1 concepts of Probability and of Statistic are developed for separate and with a formal mathematical treatment. In the Group 2, in both subjects, concepts are worked that are more related with the Statistic that is not very formal treatment that it is given, based mainly on demonstrations by means of simulation with material concrete or, in some cases, by means of the computer.

Table 1: Subjects dictated in each group of careers

Name of Subject	Group 1	Group 2	Group 3	Group 4
	Nº of weekly hours	Nº of weekly hours	Nº of weekly hours	Nº of weekly hours
Probability	6			
Statistics (or Statistics I)	6	8	4	4
Quantitative Methods		4		
Statistics II			4	

Note: All the subjects are dictated in a quarter.

Since the Group 1 is compound only for students of Faculty of Mathematics, it has been foreseen for the 2006, to add an optional subject in the one that the didactic treatment of the contents is contemplated developed in Probability and Statistic. This will help to that the students have the possibility to think the concepts developed from the didactic point of view and of the implementation in the classroom.

In the Group 3, two subjects are developed in those that one gives a similar focus to that of the Group 2, with the difference that, in the case of Statistical I, one has the same program of contents that in Statistic of the Group 1, but with 2 weekly hours less for what becomes impossible to be able to develop in the quarter all the foreseen contents. In Statistic II, one works with the computer in all the topics that are developed, but this subject is of optional character for what are few students that study it, they only make it those that have begun to carry out its thesis and they has the necessity to use concepts related with the design of experiments. The program *SPSS* is used, and in some occasions the program *EXCEL* is used, and all the proposed activities are based on designs of experiments in Biology.

In the Group 4, only concepts basics of the Descriptive Statistic univariate and bivariate are given. In this case they attend class students of four different careers that they are those that have included in this group, for that the administration of the class, in occasions, becomes complicated when having students with different restlessness.

In the Groups 2 and 4, we works very little with the computer because the groups are composed by a very big number of students, of 60 at 90, with what becomes impossible to work in the respective computer science rooms in those that it is only had approximately a maximum of twenty computers. In some occasions it is used a projector to show some simulations or data that allow to make intuitive demonstrations of some concepts (Tauber, 2001).

The Group 2 correspond to a career that is dictated in a private University, while with the Groups 1, 3 and 4, one works in a state University. The problem of the administration of the class due to the great number of students that is common in both universities.

Starting from the analysis of the curricula we want to carry out a contribution to improve the teaching of the Statistic, considering that this will be a very important tool in the professional life of our students. In consequence, we propose:

- To include in Mathematics' Faculty (Group 1) a subject of optional character, in the one that the same concepts are worked developed in Probability and Statistic, but in this occasion, adding a focus related with the Didactics of the Statistic with the purpose of that the students have a reflection on how to develop these topics when the moment arrives them of working as educational.
- To debate the problem of the number of students for course in the Degree in psychology (Group2), with the purpose of being able to give to the subject a more current treatment being able to use some type of statistical Software. We believe that this way to work will redound in the benefit of qualifying the students in knowing how to apply these results in a coherent way to the problems of its discipline.
- Intends to add more weekly hours and to reduce the quantity of students for course in the Group 3, with the purpose of being able to develop all the foreseen contents, which we consider that they are necessary to be able to develop the specific concepts of the multivariate analyses.

STUDY ABOUT THE UNDERSTANDING OF THE MEANINGS OF STOCHASTIC CONCEPTS

As consequence of our work like teacher in the subjects mentioned and having as objective that our students achieve a good understanding of the Statistic, in the year 2005 have begun to work in an investigation project whose general objective is to investigate about the understanding in those stochastic concepts that have bigger semiotic difficulty for the students because, for its understanding, relationships should be used among statistical objects of different characteristic, and of describing they consist the difficulties of the students' understanding on what.

Other specific objectives in the investigation project are: To improve the yield of the students in the subject. To favour the understanding the stochastic concepts, with the purpose of providing significant tools for the teaching from the Statistic. To favour the construction of the student's critical thought. To facilitate the acquisition the stochastic reasoning.

The Project has a 3 year-old duration, being in the initial phase of a series of activities that we have planned. Inside this initial phase, we carried out a survey on understanding of basic statistics concepts, such as reading and interpretation of charts of frequencies univariates and graphics of bars and sectors. The questions carried out were built by the members of the project.

At the beginning of the first and second quarter of 2005, has spent the survey mentioned to all the students of the mentioned careers and, now, we are in the stage of analysis of the answers of the students. The results will be presented in a poster to ICOTS 7.

Another phase of the investigation is to carry out a semiotic analysis of a sample of books of text of all the educational levels, with the objective of observing the topics that they are developed in them, what treatment type they are given to these topics and to detect if there are some conceptual errors. This phase thought about like a necessity since many professors develop their classes based on this books that sometimes present inappropriate treatment of these concepts.

Starting from this information, and basing us on the *Theory of the Semiotics Functions* (Godino, 2003) and in other investigations as, Batanero (2001), Tauber (2001), Cobo (2003), we seek to modify some points of the curricula and we want to elaborate didactic sequences based on the difficulties.

FRAMEWORK

Before the application of the survey, we was carried out a text analysis following the methodology outlined in Godino (1999), with the objective of identifying the different types of *meaning elements* and of *semiotics functions* that, from the institutional point of view, they should put at stake in the resolution of the proposed tasks. Following Godino (2003), we understands for *elements of semiotic meaning*: *"to the variety of elementary objects that are part of the systemic meaning of a mathematical object, such as actions, representations, arguments and validations that are carried out when a person works with a mathematical object."*

The categorization in *meaning elements* (See Godino, 2003) and in *semiotics functions* it allows to describe the *institutional meaning* that the professor will use to evaluate the student's understanding. This understanding can be observed by means of the "it distances" that is observed among the *personal meaning* used by the student and the *institutional meaning.*

This initial categorization allowed us to detect a series of basic elements that should put on in relationship to achieve the correct interpretation of a chart of distribution of frequencies or of a graph of bars, e.g., to be able to decide if a graph of bars in three dimensions is correct to represent data qualitative univariates. In this example, the student will relate basic concepts such as variable, categories, frequencies, correct representation when only works with a variable and the frequencies corresponding to each category, etc.

The detection of these basic elements of the *institutional meaning*, allows us to analyze which they would be the contents that the student should know to carry out interpretations and correct readings of these descriptive representations.

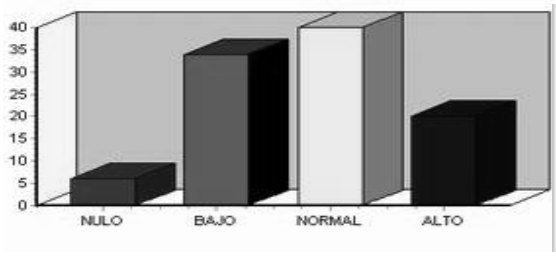
ANALYSIS A - PRIORI OF THE SURVEY PILOT

We describe the analysis a priori carried out based on a survey pilot. The main objective was obtain data on the intuitive knowledge that the students present before to develop specific topics of Descriptive Statistic and to know how reads and interprets some types of graphics and charts a citizen that doesn't know specific topics of Statistic and that periodically is presented, from the medias.

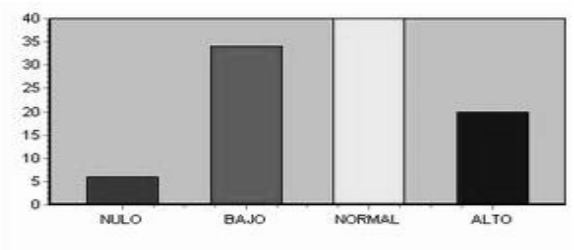
Items N° 1 and N° 2: The same ones correspond to the search of information about the previous knowledge that the students possess on Statistic, I eat the topics developed in those cases in that the students have manifested to have studied this subject at some time likewise.

Item N° 3: In the following diagrams of bars the representative frequencies of the yield are shown in Statistic of a group of 100 students.
a. Which graphics you would choose to represent the characteristics of this group?. Explain your election.
b. Carries out a comment on the main characteristics of the group that can be extracted of the graph that selected in the point to.

3.1. Plot 1



3.2. Plot 2



In this item, the information was presented through two diagrams of bars. The objective is observing which the intuitive knowledge is with regard to the information that is received to newspaper through the different media. For such an end a graph of bars was used, which is used as distracter, in which is reflected in an incorrect way the information due to the presence of a third dimension that doesn't represent any variable. This graph type is used because commonly it is presented in publications of massive consumption and we sought to investigate if the students can distinguish the most appropriate form of presenting the information in those cases in those that it is representing categories of a qualitative variable and the corresponding frequencies.

Table 2: Elements of Institutional meaning used in item 3

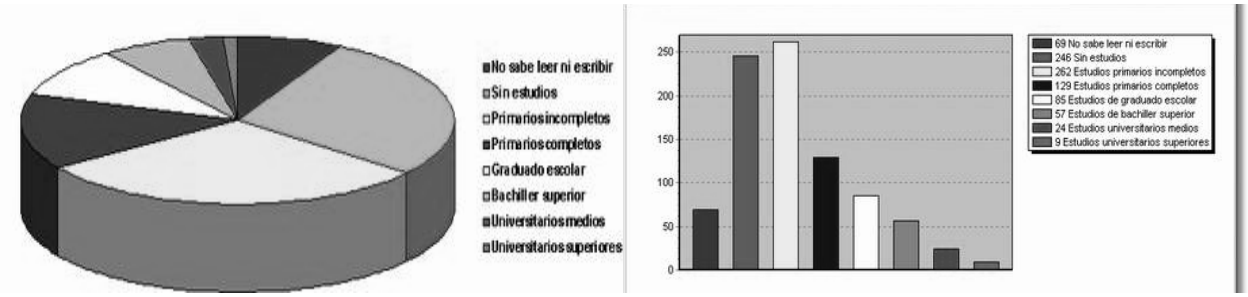
Meaning elements	*Institutional meaning local used in item 3*
Ostensive (Graphic)	graph of bars (n° 1 is correct)
Ostensive (Simbolic)	Categories and subdivisions of the axes. Scale. Titles in the axes (incomplete information)
Intensive	Absolute frequencies. Agreements of construction of graphics. Scale and height of the bars. Qualitative variable. Correspondence between variable and graph type Interpretation of the third dimension (not valid in this case).
Actuative	To identify missing information. To read, to interpret and to explain the information contained in the diagrams. To make a decision.
Validative	Justification by means of the characteristics that it should present a diagram of bars.
Extensive	Representation of a distribution of frequencies by means of diagrams of bars.

In the Tables N° 2, N° 3 and N° 4 the *meaning elements* are described, from the local *institutional meaning* (Godino, 2003), that seeks to put at stake in the resolution of the questionnaire. The students should relate these *meaning elements* in different semiotics functions. For example, a person that makes the decision of using the diagram of bars 1 is not only making a correct decision but rather also putting in interrelation several *elements of meaning* of different nature. Some these elements are: to read of the information contained in the graph (*actuative element*), relationship between height of a bar and their correspondence with the frequency

(intensive element), relationship among the variable type and the graph type that it corresponds (intensive element), identification of data lacked in the graph just as the titles in the axes (*actuative element*), etc. These *meaning elements* don't show in an unconnected way, but rather on the contrary, they are presented related by means of a semiotic function complex.

Item N° 4: In diagram of sectors and in graph of bars, the distribution of frequencies on the level of studies of a sample of 881 people interviewed in the Santa Fe city in the year 2003 is represented.
a. What general conclusions on the sample it could extract of these graphics?.
b. Which of them you did observe to reach their conclusions?. If you observed both, how characteristic it extracted of each one?

4.1. Graph of sectors *4.2. Graph of bars*



So much the diagram of bars as the graph of sectors, they represent the same distribution of frequencies. The objectives of this item are: to observe the conclusions that extract of each one of them, to determine if the students know how to distinguish which of these graphics it is the most appropriate to represent this information, to observe what elements of the graph they are observed to carry out the reading and interpretation of the same one. It is worth to mention that the diagram of sectors plays the distracter role because in him incorrect information is presented, just as using a third dimension that doesn't represent any variable; not to show the percentages corresponding to each category; high number of variables that makes that some sectors are very small or don't present too many differences to each other.

Table 3: Elements of Institutional meaning used in item 4

Meaning elements	*Institutional meaning local used in item 4*
Extensive	Representation by means of a diagram of bars and sectors of a distribution of frequencies
Ostensive (graphic)	Diagram of bars (correct). Diagram of sectors (distracter).
Ostensive (verbal)	References in both diagrams.
Ostensive Simbolic)	Titles in axes, scales.
Intensive	Agreement of reading of graphs. Representation of scale and height of the bars in the corresponding diagram. Characteristic of graphics of bars and sectors (for example: the graph of sectors is adapted to represent a reduced number of categories, the third dimension, what represents each sector, etc). Qualitative variable.
Actuative	To read, to interpret and explain the diagrams of bars. To make a decision. To extract conclusions.
Validative	Justification by means of the characteristics of the diagrams (for example: the third dimension cannot be represented, it lacks of the percentages in the diagram of sectors, which is not adapted for many categories).

In the item 5 the numeric information corresponding to the graphics presented in the item 4. The objective is observing if the students can add some additional information to the conclusions extracted and to detect possible errors regarding the election of graphics. This task allows observing if the students interpret the numeric information correctly and if they are able to detect characteristic additional of the sample that have not been detected in the graph.

Item N° 5: In the table, the numeric information corresponding to the graphics (item 4) it is added.
a. Could you add some additional information to the conclusions extracted in the article 4.a?
b. Which of the two graphics he does find more appropriate to represent these data?. Why?

Table of frequencies on level of studies (Santa Fe, 2003)

Categories	*Nº people*	*% of people*
Doesn't read neither writes	*69*	*7,8*
Without studies	*246*	*27,9*
Incomplete primary studies	*262*	*29,7*
Complete primary studies	*129*	*14,6*
Studies of graduate school	*85*	*9,7*
Studies of superior high school	*57*	*6,5*
Incomplete studies university	*24*	*2,7*
Complete studies university	*9*	*1,0*
Total	*881*	*100,0*

Table 4: Elements of Institutional meaning used in item 5

Meaning elements	*Institutional meaning local used in item 5*
Ostensive (numeric and simbolic)	Table of frequencies. Absolute and percentage frequencies.
Ostensive (verbal)	Categories
Intensive	Frequencies. Percentage. Variables. Scale. Appropriate graphics for this situation (to observe type and quantity of categories, used frequency).
Actuative	To read, to interpret and to explain the diagrams of bars. To make a decision. To extract conclusions.
Validative	To read and to interpret the information in the table. Justification in function of the characteristics of the elected diagram.

CONCLUSIONS

We have built and analyzed a survey pilot that is used to determine the intuitive knowledge of the students in connection with the interpretation of numeric summaries and simple graphics and to explore the possible misinterpretation in this type of statistical information.

Although we have only worked with simple tasks of Descriptive Statistic, the adopted framework has allowed us to identify the complexity semiotic that present this tasks, in those that it should be kept in mind a series of elements of meaning of different nature that should put on in relationship to be able to make an appropriate decision and to interpret the information correctly.

From the point of view of the teaching of the stochastic concepts, this analysis a priori allows to detect all the concepts that are implicit when we build or we read certain statistical summaries, as they are it the graphics and the tables of frequencies. These implicit concepts should be kept in mind when teaching graphics and charts.

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