INVESTIGATION ABOUT CURRICULAR ORIENTATIONS IN TEACHING STATISTICS IN BRAZIL AND MEXICO

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The objective of this paper is to investigate similarities and differences between curricular orientations for teaching statistics at a Brazilian high school and the School of Sciences and Humanities (CCH) in Mexico. CCH is an important Mexican institution and one out of three high school systems offered by the National Autonomous University of Mexico. In Brazil, the curricular orientations are recommended in the National Curricular Parameters (PCN). Among the differences, the CCH's curriculum includes Inferential Statistics, particularly Estimation and Test of Hypothesis. Curricular orientations are similar in recommending collecting, organization and presentation of data; construction, reading and interpretation of graphics, tables, measures of central tendency and dispersion; observation of the random character of phenomena, construction of sample space and probabilities calculations, aiming to develop the statistics literacy of the students. Comparison between both curricular orientations may contribute to thinking about teaching statistics in high school.

INTRODUCTION

At the present time, and living in a world with increasing interaction and common aims, we may think that at least the curricular contents of scientific knowledge are more or less the same in different countries for the same scholar level. In this article we intend to compare the curriculum for high school level in Brazil with the curriculum for one of the biggest high school systems in Mexico. The idea is not just to compare the contents, but some of the didactical orientations and the main purposes in both cases.

In the first two sections, we are going to describe briefly each case. In the third section, we are going to identify and discuss similarities and differences.

MEXICAN CASE

The School of Sciences and Humanities (CCH) is a high school system depending directly on the National Autonomous University of Mexico (UNAM), the most important educative institution in the country. The CCH consists of five campuses in Mexico City and about 60,000 students. The whole schooling lasts three years, under a half-yearly scheme; the first two years, all students must cover the same 23 subjects, including four Mathematics subjects in which there's not a single content in Statistics. In the last year, the students may choose with certain degree of freedom their subjects for the courses, having to pick, among some other decisions, one or two subjects from Cybernetics, Calculus and Statistics. With this scheme, just some of the students will have the chance of learning statistical content in the CCH (Colegio de Ciencias y Humanidades, 2005, p. 23).

At the moment of writing this document, the CCH is going through a process of curricular actualization, which is going to finish by November 2013. So, the proposed scholar program that is going to be delivered on November 2013 is not yet officially published, but is an open document. It can be noted that the contents are the same in the existing program and in the proposed new program.

The contents are:

- Basic Concepts: Statistics, population, sample, variables and types of variables, sampling, tendency, variability, distribution, etc.
- Descriptive Statistics: Tables, graphics, measures of tendency, variability and position.
- Bivariate Data: Scatter plot, regression, correlation, contingency tables.
- Probability: Subjective, frequency and classic probability, sample space, events, exclusivity,

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independence, conditional probability for two events, contingency tables, tree diagram. Note that combinatory and sets are not themes for the probability contents.
- Distributions of Probability: Random variables discrete and continuous, expected values, distribution of probability for a discrete variable, Binomial and Normal distributions.
- Sample Distributions: Distributions of probability for mean and proportion, Central Limit Theorem.
- Inference: Intervals of confidence and test of hypothesis for mean and proportion. (Colegio de Ciencias y Humanidades, 2005, p. 8).

The difference between them is that the new program focuses on helping the students to form and consolidate their *Probabilistic Thinking*, as defined by Salcedo (2005, p. 7): "Involves the comprehension of the why and how are the statistical surveys made, understanding how the models are used to simulate random phenomena, how data are produced to estimate probabilities, and recognizing how, when, and why existing deductive instruments can be used; It means also to understand and use the context of a problem to issue findings and plan investigations". This leads to enabling students to be capable of reading and interpreting statistic information, as well of producing it.

It also emphasizes on developing in the students the ability of making informal and formal inferences, where *Inference* refers to the conclusions that can be drawn about the behavior of a variable in a population, based on the information obtained from a sample, considering the variability and randomness in sampling. It can be operated at two levels: informal and formal. Informal is the way in which students use their knowledge and experience to propose hypotheses about an unknown population from partial samples of these populations, with its main components being reasoning about i) the possible characteristics of a population based on a sample, ii) the possible differences and relationships between two populations from two samples, and iii) the variability of the data samples. The formal allows inferences about a population through the application of procedures and specific statistical methods (Rodríguez, 2012, p. 5).

Another important improvement in the approach to the statistics contents in the new program is supporting the whole course on *statistical investigation*, as defined by Peña Sánchez de Rivera (2000, p. 28): "Collection and descriptive and exploratory analysis of the initial data (data description); construction of a probabilistic model (probability distribution models); estimation of its parameters using a sample (estimate of the model); simplification of its structure (test of hypothesis) and analysis of their adequacy to the studied reality (diagnosis and criticism in front of the model)".

Finally, in the existing program, the use of technology is suggested and encouraged. In the new proposal, the use of the computer and calculator has the same level of importance as the use of manipulative material for the physical simulation. The document states "Supporting the development of the process through the use of computer in learning experiences must transcend the mere use of data processors which facilitate calculations. It's intended, in this way, students to assimilate probabilistic concepts through simulation, to interpret statistical information and to carry out and validate their first inferences, being this the conception of the use of the computer within the course" (Colegio de Ciencias y Humanidades, 2013, p. 9). This points out that the core of the course is based on the use of the computer as a tool to develop probabilistic thinking in the students.

BRAZILIAN CASE

In Brazil, Basic Education consists of elementary and secondary education. Secondary education covers the last three years out of twelve, with students aging from 15 to 17 years, being so the equivalent of high school.

For Basic Education, the orientations for the content, the didactical approach and the expected final profile of the student, are written on the National Curricular Parameters (PCN), prepared by the Ministry of Education in 1997.

For Statistics, the PCN states different themes at different levels of knowledge not just for the secondary school, but for the each one of the twelve grades of Basic Education. This means that

every student starting the last year of high school already has a certain level of statistical knowledge.

For the high school level, the PCN identifies the following contents:

- Descriptive Statistics: Description of data, graphics, measures of tendency and variability.
- Combinatory: Product Theorem, problems of counting.
- Probability: Randomness, probabilities calculations, predictions, statistics and probabilities in contexts. (Ministry of Education, 2002, pp. 127-128).

With the PCN, the Ministry of Education emphasizes some guidelines for carrying out the statistics content in the courses. For instance, students have to construct inferences from data, which fits the ideas of informal inference of Rodríguez (2012, p. 5), stated earlier in this document. The students are also expected to work with projects of statistical investigation within a context, and aim for transversal knowledge.

The PCN also suggests that for students to learn Statistics and Probability, the classes should be supported by simulations, modeling and the use of computers and calculators (Ministry of Education, 1997), as well as working cooperatively in solving problems and conducting projects.

COMPARING BOTH CASES

CCH, and UNAM more broadly, define the scholarly program not just for themselves, but also for many other educative institutions in Mexico, with their influence one of the most important at national level. In the Brazilian case, the national orientations and the scholar programs to the whole public education in the country are dictated by the Ministry of Education. In this way, analyzing both cases provides broad information about not just two institutions, but about both countries.

With a quick view, we may find immediate differences between both cases, the most evident related to the content. But this contrast should go deeper.

The most significant differences between both curricular orientations are:

- The contents are more extensive in the CCH program, whether it is the existing program or the proposed program, than the content established by the PCN.
- In CCH, the students are expected to learn formal inference, even at a very basic level.
- Students starting their last year of high school in Brazil already have some background in Statistics, following the whole Basic Education grades, while the background in Statistics for the CCH's students starting their last year of high school is expected to be very poor.
- In CCH, the students are not expected to learn Combinatory in the Statistics course, while in Brazil they are.
- Statistics in CCH is a subject apart from the rest of the Mathematics syllabus, while Statistics in the Basic Education in Brazil is part of the Mathematics programs throughout the twelve years of schooling.
- The PCN were prepared by the Ministry of Education of Brazil. The scholarly programs of the CCH are produced by the CCH, which means that the only participation comes from within the UNAM –as an autonomous entity, even when it's a public school- with no interference from the Ministry of Education of Mexico.

The most significant similarities found are:

- PCN and CCH programs emphasize informal inference.
- PCN and CCH programs encourage the use of simulations for learning statistics and probabilistic content.
- PCN and CCH programs encourage the use of calculators and computers as a support for the Statistics class.
- PC and CCH programs encourage problem solving, modeling, working on projects and statistical investigations, transversal learning, communicating ideas, where students are working cooperatively.

- PC and CCH programs aim to develop in students the ability to make decisions, as well as the ability to make some predictions based on data.
- PC and CCH programs aim to develop students who are capable of critically reading and producing statistical information.

CONCLUSION

Most of the similarities found, are in the ways the scholarly programs are intended to be carried out. In both cases it seems that teaching Statistics by merely repeating mechanical processes of calculations is not operating any more. This is evident by an exhaustive reading of the CCH programs and the PCN (2006), which is not detailed at this point.

In both cases, the orientations are recent and developed according to the observations and investigations made by the international community of researchers in Statistics Education. This points out that in both countries efforts to improve the level of statistics education at high school are being made.

Statistics within context, statistics literacy, transversal knowledge, the capacity of working cooperatively, the use of technology and the ability to question information, appear in both cases as the objectives behind learning statistical content, even when the content is wider for the CCH. All these ideas, seem to be guiding the tasks of the school widely nowadays.

It can be noted that in both cases Informal Inference is present, but Formal Inference is present in just one of them. The importance of Inference has been widely discussed, and having two systems that teach it in different ways, may allow comparison of results to find the best route to teach this subject.

There's still the question about whether students actually learn Statistics in each case, at least as the way as it is intended. Another question is the effect that differences between both cases may have for learning. Investigating these ideas may contribute to thinking about teaching statistics in high school.

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