Towards Statistical Literacy

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Introduction

Statistics has played a major role in the development of modern society, to provide general methodological tools to analyze the variability, determine relations between variables. Designing optimal studies and experiments and improving predictions in situations of uncertainty. This led Argentina and other countries to initiate the training of statisticians for more than 50 years (Haedo, 2001).

More recently the teaching of statistics is incorporated, in schools, institutes and University courses.

In addition to its instrumental character to other disciplines, recognizes the value of the development of statistical reasoning in a society characterized by the availability of information and the need for decision-making in environment of uncertainty.

In this paper we reflect the progress made in this direction and the main obstacles to achieve this goal. We also suggest the important role of the statistical institutes, teachers and researchers to achieve a statistical literacy for all.

Statistics as a Cultural Component

According to Holmes (2002), the teaching of statistics and probability was already introduced in 1961 in the curriculum of England in the optional form for students from 16 to 19 years who wanted to specialize in mathematics in order to show the applications of mathematics to a wide range of subjects. Holmes and his team, with the School Council project (Holmes, 1980) showed that it was possible to begin education from primary school, justifying it by the following reasons:

- Statistics is a part of the desirable general education for the future adult citizens. Those who need to acquire the capability of reading and interpretation of tables and statistical graphs that frequently appear in the media.
- It is useful for the later life, as in many professions require a basic knowledge of the subject.
- The study of this discipline helps to personal development, fostering a critical reasoning, based on the evaluation of the objective evidence.
- Helps to understand the remaining topics of the curriculum, both of compulsory education as a subsequent, where often there are graphics, summaries or statistical concepts.

These recommendations made that statistics is incorporated more and more to the curricula. For example, Terán (2002) analyzes the contents of the Federal law on education in Argentina, her ranging from basic General education to high school. The main objective is not to turn future citizens in "statisticians" because we all know that, reasonable and efficient implementation of statistics for the resolution of problems requires a comprehensive knowledge of this discipline and is the responsibility of professional statisticians. Nor is it training them in the calculation and graphical representation, since computers today resolved this problem better and quicker. The idea is to provide a statistical culture, "concerning two correlated components:

a) capacity to interpret and critically evaluate statistical information, the arguments based on data that people can found in various contexts, including the media,
b) Ability to discuss or communicate their views with respect to such statistical information where it is relevant "(Gal, 2002, pp.2-3).

The term, which has been emerging spontaneously between statisticians and professors and teachers of statistics in recent years, is to highlight the fact that statistics is considered today as part of the necessary cultural heritage to educated citizens.

Also official statistical agencies have raised the need to get the studies made in an understandable manner to all citizens and at the same time improve the public image of the statistics. In addition to the emphasis on the provision of information and advice to the Government and professional and research use, the official statistical organizations are interested in providing information to society as a whole.

What an When to teach Statistics in order to achieve Statistics Culture

In a changing and unpredictable society, such as where we live in, we feel insecure about the best way of preparing young people and which are the subjects and content to teach. What today may seem us essential can become obsolete in a not too distant future time. We all have the experience to have devoted many hours in our childhood to acquire skills for mathematical calculation that today are unnecessary, due to the presence of calculators and computers so ¿Which are the skills, knowledge and values that remain unchanged or that prepare for the future training? Watson (1997) presents a model that includes three components of progressive assimilation:

- basic knowledge of probabilistic and statistical concepts,
- the understanding of the reasoning and statistical arguments when presented in a broader context of any report in the media or at work and
- A critical attitude assumed by questioning arguments that are based on not enough statistical evidence. GAL (2002) based on this model and others built his own model that includes elements of statistical and mathematical knowledge, basic skills of reading, knowledge of the context and critical capacity. We therefore see that statistical literacy is more than just capacity and knowledge of definitions.

Knowledge and skills

Recent Americans standards curriculum (NCTM, 2000) includes the following recommendations of what children of levels of 3 ° to 5 ° must be able to do:

• designing research to answer a question, and consider how the methods of data collection affect the set of data.

• Collect data of observation, surveys and experiments.

• Represent data in tables, line charts, points and bars.

• Recognize the differences to represent numeric and categorical data.

• Use measures of central position, particularly the medium and understand what each one indicated on the data set.

• Compare different representations of the same data and assess what aspects of the set of data are best displayed with each of them.

• Provide and justify conclusions and design studies to better study the conclusions and predictions.

At these levels are intended to progressively children able to see the data as a whole set, describe its form and use the features statistics, such as the range and measures of central tendency to compare sets of data. They should be considered that data are samples collected from greater populations and carry out research and projects, whereas the cycle: ask questions, collect data and represent them.

Statistical Reasoning

The above objectives relate not only to conceptual or procedural knowledge. Statistical reasoning is a vital component of learning. This type of reasoning included according to Wild and Pfannkuch (1999) five fundamental components:

• recognize the need for the data: the basis of statistical research is the hypothesis that many real-life situations can only be understood based on the analysis of data that have been collected in an appropriate manner. Personal experience or anecdotal type evidence is unreliable and may lead to confusion in the proceedings or decision making.

• Transnumeración: The authors use this word to indicate the understanding that can arise when you change the representation of the data. When you see a real system from the perspective of modeling, can be three types of transnumeración: (1) from the measure that "captures" the qualities or characteristics of the real world, (2) going from raw data to a tabular or graphical representation that allows to extract meaning from them; (3) to communicate this meaning that emerges from the data in the form that is comprehensible to others.

• Perception of the variation. The adequate collection of data and the correct judgments from them require the understanding of variation that there is and is transmitting in data, as well as the uncertainty caused by unexplained variation. Statistics allows you to make predictions, find explanations and causes of variation and learn from the context.

• Reasoning with statistical models. Any useful statistical, even a simple graphic, a regression line or a summary can be seen as a model, since that is a way to represent reality. The important thing is to differentiate the model data and at the same time linking the model with the data.

• Integration of statistics and the context: is also an essential component of the statistical reasoning.

This model describes the statistical reasoning on a global basis.

How to develop statistical culture

It is clear that the easiest way to reach all citizens is from the school. Accordingly, education authorities and designers of the curriculum are the primary responsible to achieve a statistical culture for all.

Training and motivation of the teachers,

However, the fact that statistics is included in an official manner in the curriculum does not mean it is necessarily taught. On the other hand Holmes (2002) indicates that the lessons of statistics, within the books

of mathematics have been often written by mathematicians. In this case, the priority objective is mathematical and not the statistical activity. Therefore applications are not really important and students end the courses without acquiring a real competition for carrying out a statistical research. In addition to the change of the curriculum arises the need of didactic training of teachers that includes not only the statistical knowledge but what is known as 'educational knowledge of the contents' (Thompson, 1992).

Initiatives from Statistical Offices

The responsible for the development of statistics (institutes and Government agencies, research centre) need the cooperation of all in the process of data collection. It is important to make aware the people of the problems that can arise from the non-response, non-truth or missing information. We must also increase their confidence in the confidentiality of the information and show them how their collaboration in the process of a survey may serve to make the right decisions that reversal for their own benefit and in the overall development. This concern to make statistics understandable to all citizens is leading these agencies to become involved in an active and growing way in the development and dissemination of resources for teaching. A good example is the ALEA project (Campos et al., 2001) which provides support for the teaching of the statistical instruments for students and teachers of primary and secondary school (http://alea-estp.ine.pt). Also the school mini-census, with the dual purpose of informing students what a census is, the type of information collected and how is processed, and, in another hand, increasing the interest and participation of parents and citizens in general, in the preparation of the census. Similar projects have been developed in relation with the Census 2001 in other countries; for example, in the United Kingdom, Italy, South Africa, Australia and New Zealand. This information is periodically updated on the website (http://www.censusatschool.ntu.ac.uk/). Another example of this interest is the recent European Conference on teaching and learning of statistics organized by the Balearic Institute of statistics in 2001.

Research and Statistical Culture

As any other human activity, education is based on scientific and technological advances. This central role of research in the pursuit of the improvement in the statistical literacy is highlighted, among others by Watson (2002). Fortunately, in recent years research in statistical education has experienced a strong advance.

This type of research began in a dispersed form, from different areas of knowledge. For example, in psychology two working groups have focused on this topic have been those of reasoning on decision making in situations of uncertainty, and the evolutionary development of stochastic reasoning.

Research on statistical education not only has a value in itself, but it has helped to disseminate and teach better the discipline. To be effective, the research must be known and researchers must build their input on what already exists. Today research cannot be carried out in isolation and communications has helped distance work, including interdisciplinary work.

Conclusions

Undeniable is that the 20th century has been the century of the statistics, which has come to be regarded as one of the fundamental methodological science and basis of the experimental scientific method. As Cox (1997) suggests there has been a notable increase in the use of statistical ideas in different disciplines, seen in scientific journals and the increasing involvement of statisticians in the interdisciplinary working teams. However, at the recent Conference organized by IASE on the training of researchers (Batanero, 2001) revealed that the statistic is used incorrectly, basic concepts are not understood and there is not yet enough valuation of the work of a statistician in a research team. We think that this indicates the existence of an

educational problem that is rooted in that the incorporation of teaching basic statistics at school is not yet a fact. Although primary and secondary education curricula include it, teachers often leave this issue to the end of the program and often omit it. Students come to the University without the basic knowledge and need to start the program by repeating the content of descriptive statistics and calculation of probabilities which should have been assimilated at school.

University professors, who should try to reach the statistical - at least in their early inference - because this part is that will truly be more useful for students, they must accelerate the explanations, removing the practical activities and much of the proofs or arguments which might lead students to better understand the methodology of the statistics.

All these problems are compounded by overcrowding of the courses and the lack of resources (such as computer labs or teachers assistants) to enable more personalized attention and a more applied teaching of statistics.

It is not surprising that students are discouraged and statistics ends being one of the less popular subjects for students.

On the other hand, the students not only learn statistics in instructional or educational establishments. We not only find statistical information in the press and media or the texts of other subjects, but that the Internet itself is beginning to change the educational relationship - with or without voluntary participation of teachers.

It is clear that teachers - in the various educational levels - we have to accept that the speed of technological change and engage with it, if we want to guide the statistical education in some way, and create a true statistical culture in the society.

Malvicini and Severino (1999), indicate that certain statistical concepts are highly sophisticated and should take into account the difficulties of students in the learning them, incorporating new technology for education, textbooks and teacher training.

We need, therefore, the help of education researchers to identify the different levels of understanding that are feasible and useful to our students, as well as educational practices that can lead to these modes of understanding.

Experiences directed from the departments of statistics, as, for example Aravena and cols. (2001), servers of teaching support on the Internet, such as the built in Valparaiso University (http://www.ucv.cl/web/estadistica/) and innovative books, as the Aliaga and Gunderson (1999) are essential.

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