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Statistical Education for Communicating in Modern Societies[1]

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1. Introduction

During the last few decades everyday life has deeply changed, mainly improving its quality as well as social and individual behaviour. This trend has been observed, even if at different levels, in most countries and it depends on many reasons. Though we are not directly interested in the reasons and the characteristics of this evolution, the phenomenon is very important for analysing some aspects concerning the *quantitative literacy*, or *numeracy*.

The education level is rising everywhere and the average individual culture is increasing. Many facts contribute to this phenomena: first of all, more students attend higher school levels, and also a very important role has been played by mass media. Television, newspapers, magazines, etc., have substantially contributed to spread out every kind of information on social life and this information has become more and more advanced, detailed and documented so that people have got accustomed to have many elements available to understand better some social facts. Furthermore, the fast progress of technology has fostered this course making available new powerful tools for acquiring, processing, and disseminating information.

However, very often the nature of some facts cannot be explored without examining their quantitative aspects so that progressively a "new technical language", suitable for this purpose, has appeared and is currently used. Unfortunately, technical languages consist mainly of a few words

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that refer to specific concepts. Therefore, to allow a correct communication, they require a specific skill that cannot be taken for granted, mainly when we refer to population in general.

The present research intends to develop a reflection on what we take as one of the fundamental aspects of the communication process, that is the exchange of information. We well know that the concept of communication corresponds to that of exchange and mutual interaction, and that a correct functionality of the communication process presumes equal conditions between the transmitter and the receiver of the information. Nevertheless, we desire to focus our attention on the modalities used by who controls the process of transmission of information through mass-media. We want to reflect on how information is transmitted today, with which means and, above all, on the knowledge of those who spread and receive information and how they interpret it. However, we want to underline how, more and more, *statistics* (increasingly seen as a *new language*) is used to exchange information and how much the *knowledge* and *competence* of the persons involved are insufficient.

Finally, it is necessary to notify that our opinions are mostly based on the Italian situation, however the main aspects of the problems here examined are common to many western countries as well as to some other developed and developing country.

2. Communication and statistical culture

We don't want to dwell upon the different aspects of the theory of communication because of problems of space and, above all, because it isn't of our interest. However, allow us a few words on communication among human beings.

When talking about communication among human beings, we realize that the language allows us to exchange a great number of meanings, that each linguistic message has different meanings and, above all, that the decoding process in language interaction is never a mechanical comparison between the signals received and an abstract code. It's an *interpretation* process in which the context, the emotional state and the knowledge of the receiver play a fundamental role.

Every communication process between intelligent beings based on a "complex code" (like *language*) doesn't always result in a perfect correspondence between coding and decoding. This happens above all when the domain is specific (painting, cinema, technology, etc.) and needs particular assumptions. The decoding always requires a amount of *interpretation*, done by the receiver or receivers under the light of a set of competencies and circumstances.

In the last few decades, communication means (the so-called mass media: radio, television, Internet and newspapers) that have been greatly transformed, include more and more "statistics" in the language they use. Information are more and more spread through tables, graphs, statistical reports. The exit polls and the projection on anticipated election results are more and more spread, just as opinion poll whose results are presented in a lot of daily and weekly papers and on popular television programs. In most of the cases, these aren't polls but the opinions of a group of people without any guarantee of statistical correctness.

Those who use statistics to spread information often don't understand it and, consequently, communicates wrongly and transmit incorrect information. Some time, they communicate only what interests them and instead of saying everything. The construction of information is a function of the ideology, of the epistemology and of the vision of reality, dimensions tightly connected with the economic and political aspects of the means in which works the one who spreads the information, with, possibly, a certain autonomy to make decisions. This explains why sometimes information is built and codified in order to convey the desired message in a more or less hidden way. It's also possible that in certain situations errors are not due to (wrong) manipulation of information but to a lack of knowledge of the statistical means used during the coding process.

However, even the one who receives the "communication" that is the information, through the mass media as statistics, graphs, etc., doesn't probably understand statistics and hasn't the necessary knowledge to understand if the message is correct or not and, consequently, is unable to distinguish a correct message from a incorrect one. Even the user is unconsciously influenced by his own

beliefs, values and standards in such a way that during the decoding process, and the interpretation of information, he will try to grasp the aspects confirming his own vision of reality.[2]

An high and professional sense of ethic should be required from those who spread information; then, a formation/information on basic statistics concepts could help this people to use statistics correctly and those who receive the information to understand more in order to interpret better.

The relationship between statistics and media plays a more and more important role, above all in a society in which statistical information is not only required by economic and social experts but also by a wider inexpert public, that in the last few years has been developing a sensitivity towards quantitative information. However, according to what we may read in the papers or listen on radio or television, we may say that the relationship between statistics and media isn't satisfying. Statistics aren't always presented accurately and adequately and often full of journalistic "howlers".

2.1. The statisticians' points of view

Michael Friendly in the Gallery of Data Visualisation displays some examples of the *best* and *worst* statistical graphics (http://www.math.yorku.ca/SCS/Gallery/) and he affirms: "Like good writing, good graphics displays of data communicate ideas with clarity, precision, and efficiency. Like poor writing, bad graphical displays distort or obscure the data, make it harder to understand or compare, or otherwise thwart the communicative effect which the graph should convey"

Naturally, the problem of statistical information through mass media isn't new and we believe that in Italy it hasn't been suitably tackled with. SIS (in 1987) and ISTAT (in 1994 and 1996 on occasion of the II and III National Conference on Statistics) have organised Sessions where the problems connected with the relationship between statistics and information were discussed extensively also comparing statisticians and those who spread information through statistics. In May 1999 the annual meeting "Statistical Output for Dissemination to Information Media" took place in Perugia and it offered an occasion take stock, at an international level, of how and how much statistical information is mediated by the mass media. This argument has been tackled and debated by several international experts particularly at ICOTS conferences.

Gani (1982) sustained : "…Statistics is a subject of vital importance: it enters substantially into the quantitative content of many (ill not all) other professional studies. Statistical information is persuasive: a detailed analysis of New York Times newspaper for Saturday, 22 may 1982, will leave us in little doubt of this fact. The intelligent reading of this newspaper, or of any other current information material, therefore makes a basic grounding in statistics essential for all citizens"

David Moore (1990) affirms "Statistics has been traditionally thought of as a rather arcane body of knowledge best left to specialists……..This is no longer the case, at least if we understand "statistics" as the science of data and chance. Statistics in this broader sense is the heart of what is more often called "numeracy" or "quantitative literacy". Numeracy, like literacy, is important not for its own sake but as a medium for expressing reasoning and communicating ideas. Changing trends in most societies will make numeracy as essential as literacy now is".

UNESCO in its actions for the cultural development and redemption of every population, tries to foster at the same time the literary and the quantitative alphabetisation (numeracy). The modern citizen needs statistical culture, but not statistics as a technique for handling data but for understanding the logical abstraction that allows to tackle the quantitative study of the collective phenomena. It's very important to remind the leading role played by the statistical culture to meet the challenge to the market globalisation. Consequently it's very important to undertake and foster

[2] It's important to note that each media has a its own specificity as to the use and the fruition. The information spread by the different mass media has different way of access (listening, listening-watching, reading) and decoding. Time is surely one of the most important aspects diversifying the mass media: an article may be read more times and in different moments and, consequently, differently interpreted; while the information spread by radio or television is much more direct (aside from video-recording) and doesn't allow to come back.

the necessary actions to let society know the logic of the discipline, of its utility and of its capacities (Ottaviani,1997).

Social changes, both in the backgrounds of entering students and in the skills valued in the labour market, challenge education systems at all levels. Technology promises to change everything, but education changes slowly. Strong education reform movements demand radical change as well, and again the response seems slow (Moore and others 1995). Experts don't pay enough attention to the didactics of statistics to create a real statistical culture. The teaching and the production of statistics don't play a leading role in the scientific panorama of the statistical disciplines. Presumably, in a few years, we will be able to see some changes.

3. Information makers

Today many kinds of job positions are related with statistics, either directly or indirectly connected. While in the first case we find people mostly enrolled because of their specific professional profile (this is the case for statistical agencies, survey companies, etc.) in the second case generally it is considered of slight importance if the employees' background includes some basic statistical knowledge. The last category is very large and includes most of the people responsible for communications, like journalists, teachers, political analysts, spokesmen, managers, and some times researchers also.

Computers today allow to easily do many statistics, graphical representations, tables, etc.; one of the most popular software, Microsoft Excel, is widely available and perhaps it is on every office desks. This means that everyone can use it, even without the necessary background, and often the software available (with a very simple online documentation) give people the illusion that one can use statistics without knowing statistics.

While modern societies often require lot of information to analyse and understand social and economic phenomena, the average personal culture is not always adequate for this job. As a matter of facts, we have to take into account that all these needs have come up very quickly during the last 20-30 years; mass media began to use this new language slightly when it was realized that it was very powerful, immediate and simple for communicating complex quantitative information. At the beginning this task was carried out only by specialists, but when the habit of using statistics became more and more widespread and this language more usual, also non-specialized people progressively began to do it by themselves. As a result, we can find in this “literature” many kind of errors, which have determined misunderstandings and often economical damages, (statistical books frequently report examples of these mistakes to show the risks of an incorrect use of statistics). Companies managers claim that sometimes decisions have been taken on the basis of a presentation that further a posteriori analysis have been revealed unclear, inaccurate and misleading. Furthermore, some messages based on the information coming from data (that should require an accurate analysis) often give only a partial idea of the phenomenon. The lack of basic statistical background can cause different effects: it not only causes mistakes, it makes people unaware of the difficulties of interpreting data and of communicating the correct information so that, as a consequence, this task can appear much more easier than it is, thus encouraging to “do it by yourself”.

On the other hand, the addressees of such kind of messages have to be considered even less skilled, so that generally they have problems to decode them. The situation becomes more and more delicate when messages are not correct, in the sense that an incorrect use of statistics leads to misunderstanding. The lack of some basic quantitative culture makes these persons completely unable to analyse, criticize, and discover whether and why the information is defective.

Communications are today so important that this problem has become a relevant social affair and it is urgent to enlarge the basic culture by introducing an appropriate training on basic statistics.

4. Teaching statistics at school: the Italian experience.

Many countries have already introduced statistics in the curricula of pre-university schools, some of them starting from elementary classes. Italy started approximately 20 years ago (the reform has not been simultaneous so that the period varies depending on the school level) so that we have been able to analyse the result of the experience carried on in this country. It is important to note that the main aspects of the Italian experience have also been observed in many other countries (mainly in Europe and North America), as recently reported by different authors at several international conferences devoted to statistics education.

It is necessary to start by saying that in Italy statistics have been inserted as a part of the mathematics curricula and that the teachers mainly have a degree in mathematics or, in some cases, in other scientific fields like physics, engineering, etc. In many cases, their curricula did not include statistics courses and, when they did, they were mostly theoretical. Practically, teachers have never received a training on the basics of statistics (descriptive statistics, exploratory analysis, and applied statistics), which are the most important aspects for teaching at school level.

When teachers had the task to include statistics into the former mathematic syllabus, they did not have the necessary competencies to transfer the basic statistical concepts. These concepts were very difficult for them to understand and after, it was hard for them to teach the meaning and the proper use of these concepts, even the simplest ones like means (median, mean and their differences) or standard deviation. However, because of their background, they could easily teach the formulas, the algebraic properties and some theorems, so that generally statistics have been presented under the same light as mathematics. The situation has remained almost the same until now. In fact in Italy we have approximately 100,000 teachers who need an appropriate training: this task implies many problems and a great financial effort, so it requires a careful planning.

5. New strategies for teaching statistics

A plan for improving the students' quantitative reasoning abilities must take into account two different aspects: good teaching strategies and appropriate trainings for teachers, both having their own peculiarities.

First of all, to select a good teaching strategy it is necessary to identify the goals (what kind of knowledge? at what level? must it also include a statistical software ability?) and to be acquainted with the impact that such strategies can have on students.

Secondly, teachers are adults: they have a limited time available and they require a different teaching approach for learning. Furthermore, most of them have a degree in mathematics so that they are more familiar with pure theoretical reasoning and abstraction then with the analysis of "real" problems through data, so that often they have to modify their settled "mode of thinking" and behaviour toward a discipline that seems like mathematics, without being mathematics. Then, a large-scale training project requires a deep analysis of the real situation and the support of pedagogues specialised for teaching to adults.

To understand better these aspects and with the objective of suggesting a feasible plan to the authorities, some of the members of the Italian Research Centre for Teaching Statistics (CIRDIS) promoted in 1998 a research program for testing and comparing some teaching strategies. This project, financially supported by the Ministry of the University and of the Scientific and Technological Research (MURST) and by the Universities of Padova, Palermo, Perugia and Roma "La Sapienza", has been carried out on the three pre-university school levels (elementary, middle and high) involving approximately 350 teachers and 5000 students. We included all school levels because statistical reasoning must become natural for students from the beginning (as it is in every day life). In fact, not only mass-media use a "statistical language", many textbooks often present some information using graphical representations, tables and elementary statistics. For instance, geographical atlases frequently use mean values (for temperature, rainfalls, etc.) or graphics to describe many aspects of various countries (economy, demography, etc.).

The characteristics of the experiment have been decided taking into account the school level. For the first level (elementary schools lasting 5 years, age 6-10) we chose to use only one teaching strategy based on the psycho-pedagogic model known as "teaching by conceptual maps".

For the second school level (middle schools lasting 3 years, age 11-14) we decided to use the teaching methodology known as “data oriented approach” (DOA) and two different pedagogic models: “ex-cathedra teaching” and “cooperative learning”.

For the third school level (high schools lasting 5 years, age 15-19) we planned three strategies, always based on the DOA

- ex-cathedra teaching
- ex-cathedra teaching with lab activities
- cooperative learning with lab activities.

One of the most important tasks for this experiment has been the choice of the teachers, and their training. To reduce the sub-experimental effects, originally we tried to assign randomly the different strategies to each teacher, but their reaction often did not permit to respect the original design. In fact, teachers had their own preferences and personal problems (sometime depending on the time available for attending the training courses) and very often we were obliged to accept their decisions.

The teachers' training periods can be summarized as follows: approximately 30 hours for first level school; 30 hours (DOA) and 12 hours (cooperative learning) for second level schools; finally, 20 hours (DOA), 12 hours (Lab) and 8 hours (cooperative learning) for third level schools. Each teacher had only to attend the courses concerned with the type of strategy he had to experiment.

The experimental period in the classrooms lasted 20 hours (for lab activities we added 4 more hours) and teachers were requested to record "everything" in a diary; the students' learning process was monitored using selected tests proposed during the experimental period.

The results are not yet available because the experiment ended in the last June and we are still collecting data. However most teachers were enthusiastic and have reported that students, mostly the ones who had problems with mathematics, have shown a great interest and great progress because they were mainly attracted by the facts that "mathematics tools" could help them to discover and understand the reality.

REFERENCES

Ciotti F., Roncaglia G. (2000). Il Mondo digitale. Edizioni Laterza.

Galmacci, G. (1998). Nuove Tecnologie e Insegnamento della Statistica. Atti della XXXIX Riunione Scientifica SIS, Vol. II (CD-ROM), Sorrento.

Gani J. (1982). The Relevance of Statistical Training. Proceedings of the 1st International Conference on Teaching Statistics ICOTS 1, Vol. 1, 50-70, Sheffield.

Golini A., (1997). Cultura Statistica, statistica e mass-media. Conferenza ISTAT-S.I.S. su “La diffusione della cultura statistica”, Roma, 26-27 novembre 1997.

Milito A. M. (1998). Il convegno di Palermo su “L’insegnamento della statistica di base”: alcune riflessioni. Induzioni, 17, 47-53.

Moore D. (1990). Statistics for All: Why, What, and How?. Proceedings of the 3rd International Conference on Teaching Statistics ICOTS 3, Vol. 1, 423-428, Dunedin, New Zealand.

Moore D., Cobb G. W., Garfield J., Meeker W. Q. (1995). Statistics Education Fin de Siècle. The American Statistician, Vol.49, 3, 250-260.

Ottaviani G. (1997). Statistica e scuola: motivazioni e problemi. Conferenza ISTAT-S.I.S. “La diffusione della cultura statistica”, Roma, 26-27 novembre 1997.

S.I.S.(Società Italiana di Statistica) (1987). L’informazione statistica nei mezzi di comunicazione di massa. Giornate di Studio, Centro Informazione Stampa Universitaria, Roma.

RÉSUMÉ

La culture statistique est devenue aujourd'hui un élément essentiel pour la communication, particulièrement dans les sociétés dites avancées. Les auteurs, analysent ce phénomène partant de l'hypothèse que plusieurs termes statistiques (et par conséquent, plusieurs concepts) font désormais partie du langage courant des médias de masse. Ils mettent aussi en évidence le fait que l'école n'est pas encore à même de fournir une formation adéquate en ce sens. Finalement, on décrit une recherche menée en Italie pour identifier les stratégies plus adéquates pour l'enseignement des statistiques dans les écoles pré-universitaires.