THE EDUCATIONAL VALUE OF STATISTICS: ANALYSIS OF ITS PERCEPTION IN A GROUP OF TEACHERS

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The present work aims to investigate the educational value of statistics as perceived by teachers involved in the teaching of this subject in schools of every type and level in the city of Palermo. To achieve this aim a preliminary fact-finding investigation was performed.

THE EDUCATIONAL VALUE: MOTIVATIONS AND AIMS BEHIND THE RESEARCH

Although the teaching of statistics has been included in the ministerial programmes of primary and secondary schools in Italy for almost fifteen years, it has in fact remained of marginal importance. It has still not yet become a teaching-learning experience rich enough to develop in young pupils the full awareness of a "statistical culture" or to foster in the schools a "culture of statistics" to reflect the importance of statistics in the world today. This situation may be explained if we examine a number of elements, which in spite of being different in nature are interconnected: the teachers' knowledge of statistics, often inadequate teaching tools (difficulty of finding suitable text books, the lack of computer laboratories in many schools….) as well as the overall organisation of teaching in autonomous schools.

One element, which in our opinion could be quite important to consider, is *what the teacher thinks statistics can contribute to the overall development of a pupil* and how necessary, as a consequence, it is to learn and put it to practical use in the field of primary and lower and upper secondary education. That means assigning an "educational value" to statistics, in recognition of the fact that in addition to being a tool and a concrete aid in the study of other disciplines, including the behavioural sciences, it also has a formative value in the broad sense of the term, contributing to the overall development of pupils, and in particular increasing their capacity for logical thinking and *problem solving*. The significance given to this aspect will determine the *mental attitude* of the teacher towards the teaching and learning of statistics and will influence more or less directly teaching decisions and choices. On the basis of these considerations we decided to perform a fact-finding investigation in a group of mathematics teachers (who are required to teach this subject by law) about their perception of statistics and their perception of the educational function they attributed to it.

CHOICE OF THE TEACHERS

The reference population for the survey included 1870 mathematics teachers from all the 148 schools in the city of Palermo. The choice of the number of teachers to be investigated took into account a number of stratification variables: school level (primary (6 to 10 years), lower (11 to 14 years) and upper (15 to 19 years) secondary schools) and the five school districts, the marked heterogeneity of the upper secondary schools and the hypothesis of a low participation in the research project and thus a high quota of non-responders. Sixty schools were chosen (40% of the total) according to the district, level (22 primary, 24 lower secondary and 14 upper secondary schools) and the number of mathematics teachers present in each school. In the selected schools we interviewed all the mathematics teachers, giving a total of 850 subjects.

The questionnaire for the survey was handed out personally to the head teachers of each institution, who, after passing them on to the teachers concerned, collected and returned them to us (a more detailed description is the degree dissertation of Leonardo Salvaggio, 2000). Of these 850 teachers, 540 replied, i.e. 63.5%. It must be underlined that collaboration in the study was higher in the primary and lower secondary (approximately 71%) than in the upper secondary schools (51%).

THE QUESTIONNAIRE

The questionnaire we constructed for the survey contained 32 items with guided replies, some of which (44%) referred to personal information about the teachers, to previously acquired

and present knowledge of statistics, professional training and teaching experience (specialised or refresher courses and teaching experimentation). In another part of the questionnaire (approximately 33% of the items) there were questions on the teaching side of statistics, about how it is perceived and evaluated (through a request for its definition), about its utility in everyday personal and social life, about the way the discipline fits into the individual's teaching, what types of competence are required and whether particular teaching methods are necessary. In the remaining part, the items referred to the learning of statistics, about what contribution this discipline makes to the overall development process of pupils and above all whether it increases their capacity for logical thinking, reasoning and understanding. In particular, the final two items were formulated in such a way that, by requiring teachers to state which strategies they thought to be most important to enhance the "educational value" of the teaching and learning of statistics, concrete proposals emerged on how to achieve this desired aim.

RESULTS
The 540 teachers who responded were distributed as shown in Table 1.

Table 1
Distribution of Teachers According to School Level and Gender

Gender	Primary	L. Secondary	U. Secondary	Total	%
Male	14	28	30	72	13.3
Female	263	140	65	468	86.7
Total	277	168	95	540	100.0
%	51.3	31.1	17.6	100.0	

Women teachers were predominant, especially in the primary and lower secondary schools (as is known to be the case in all Italian schools) The mean age of the teachers interviewed was 44 years (range 23 to 66 years), while the mean length of teaching service ranged from 15 years for primary school teachers to 18 and 20 years respectively for lower and upper secondary school teachers. Few teachers had been involved in teaching experiments (24.8%) and although most of them were teaching in primary and lower secondary schools, it was those from the upper secondary schools who felt a greater need for new experimentation. 54.8% of them had studied the basic elements of statistics and probability at the various levels of schooling, but most of them (73%, 191/263) had first studied these subjects at university. The teachers were also asked to give a definition of "Statistics", in the form of a multiple-choice question. Among the proposed replies, all of them possible, there was a more *general* one: *A science which aims to quantitatively analyse collective phenomena*, which included the others and which we felt was more complete. 66.8% of the teachers chose this reply, with a higher percentage in the lower secondary schools and a lower percentage in the upper secondary schools.

From the descriptive analysis there emerged a number of interesting differences between the various school levels. To highlight these differences we constructed an indicator of the educational value of statistics (EVSI) based on the consideration that the concept to be measured may be specified by taking into account two macro-dimensions: one referring to the educational value of statistics for the teacher and the other for the pupil. In the case of the first dimension we took into consideration a number of aspects linked to how the teachers' personal knowledge of statistics is used to understand the world around them and some linked to the role they attribute to statistics in their teaching. For the second dimension, we considered aspects linked to the study of statistics from the point of view of the pupils, to the stimuli they receive from the world around them and from the study of other disciplines. Not all the sub-dimensions, however, can be considered to have the same value. We thus thought that in the perception of the educational value of statistics the capacities which the study of statistics develops in students are of greater importance. This meant that in the construction of the indicator different weight was given to the various items. The indicator thus constructed can assign a score between 0 and 13. The following results were obtained in the 398 teachers who replied to all the items which we considered of critical importance in determining the EVSI score.

The group analysed was mainly composed of primary school teachers (54%) followed by lower secondary teachers (approximately 29%). The primary school teachers had a higher mean score with a lower deviation (range = 9) than the lower and upper secondary school teachers (range = 12 and 13 respectively). A comparison of the EVSI score with some characterising information from the individual teachers such as gender, age, length of teaching service, type of university degree and previous study of statistics, gave the following results. The men, just 13% of the group considered, were mainly upper secondary school teachers. In contrast, the predominance of women teachers was particularly evident in the primary schools. Although there were no great differences, the best scores, excluding the few teachers under the age of 30 who were numerically irrelevant, were obtained by "young" teachers aged between 30 and 40, or in any case not over 50. In the former, the result was more evident for the lower secondary school teachers than for the other school levels, while in the latter there was a clearer difference for the upper secondary school teachers. These results were also confirmed by calculating the median score. The teachers considered had a mean length of service of around 12 years. Among those with most teaching experience were the teachers from the lower secondary schools (mean approximately 14 years), while the "youngest" in the profession were the primary school teachers (mean 11 years). The mean EVSI score was highest in the teachers with a fairly long teaching experience (over 10 years of service). As can be seen from Table 2, according to the teachers interviewed, in order to enhance the educational value of statistics the most important strategy was the choice of effective teaching methods (in 32% of cases) followed by the need for specific training of the teachers themselves (28%). The need for suitable textbooks and for the reinforcement of cross-curricular links with statistics also seem to be useful strategies (respectively for 13% and 8% of the teachers).

Table 2

Percentage of Teachers and Mean EVSI Score According to School Type and Strategies Chosen to Enhance the Educational Value of Statistics

	Primary		L. Secondary		U. Secondary		Total	
Strategies	%	Evsi	%	Evsi	%	Evsi	%	Evsi
Teacher training	31.8	9.2	26.1	9.5	22.1	7.0	28.4	9.0
Effective methods	30.4	10.1	33.9	9.1	32.2	7.6	31.7	9.4
Suitable textbooks	13.1	10.2	11.3	8.2	13.1	8.1	12.6	9.3
Cross-curricular links	6.1	10.0	10.4	10.7	11.6	7.8	8.2	9.7
Other	18.6	9.4	18.3	8.2	21.0	6.8	19.1	8.4
Total	100	9.7	100	9.1	100	7.4	100	9.1

These strategies were suggested, in the same order, both by the lower and the upper secondary school teachers, with higher values for the need for effective teaching methods, and for the reinforcement of cross-curricular links between statistics and other subjects. In contrast, there was an opposite trend in the primary school teachers who gave more importance to the need for specific training courses than to the use of effective teaching methods (32% versus 30%) and relatively little importance (as low as 6% of cases) to the reinforcement of possible cross-curricular links.

Finally, the teachers' opinion of the "statistical culture" potentially possessed by pupils in Italian schools and, in more general terms, by young people, is on the whole in line with the trends shown above (Table 3). In fact, there is a distinction between the teachers of both lower and upper secondary schools and the primary school teachers. The latter maintain, less drastically than their other colleagues, that the groundwork has not yet been laid to foster a statistical culture in young people at school (74% versus 83% and 90% respectively for lower and upper secondary school teachers). This discrepancy between primary and secondary school staff can also be seen in the reasons given by the teachers to explain the lack of a statistical culture. The primary school teachers, more drastically than teachers of the other school levels, (46% versus 30% and 28%), attribute the lack of a statistical culture to the ignorance of the teachers themselves. The lower secondary school teachers indicated as a further possible reason the fact that statistics is still

studied (and taught) too little and badly (17%). Finally, it can be seen that the teachers who were most "confident" that young people are receiving a valid education in statistics at all school levels, had a higher mean EVSI score than their colleagues who do not yet believe that precise steps have been taken to foster this education (the difference, however, between the two mean scores was not more than 1 percentage point).

Table 3
Percentage of Teachers and Mean EVSI Score According to School Type and Opinion on whether the School Has Taken the Necessary Steps to Foster the Statistical Culture of Pupils

	Primary		L. Secondary		U. Secondary		Total	
Steps for statistical culture	%	Evsi	%	Evsi	%	Evsi	%	Evsi
Yes	25.7	10.0	17.4	9.7	10.1	8.1	21.0	9.8
No	74.3	9.6	82.6	9.0	89.9	7.3	79.0	8.9
Total	100	9.7	100	9.1	100	7.4	100	9.1
Principal reasons for 'No'								
Ignorance of teachers	46.4	9.6	30.4	9.5	27.8	7.6	38.0	9.3
Discipline studied little	13.5	9.7	17.4	9.2	8.2	7.3	13.6	9.2

The differences in behaviour and opinion regarding the educational value of statistics and the "culture" imposed by the discipline between primary and lower and upper secondary school teachers showed that the former have a more open attitude towards statistics and its educational value. This is perfectly in line with nation-wide experiments in the teaching of statistics, which saw the best results produced precisely by the primary school teachers (Rigatti, Perelli, Moncecchi, & Giambalvo, 2000).

FINAL REMARKS
The results obtained suggest that there is a substantial divergence, in opinions and attitudes, between primary school teachers on the one hand and lower and upper secondary school teachers on the other. In fact, although only 37% of primary school teachers have studied statistics, they are the only ones who attribute to statistics the educational value it deserves. Their secondary school colleagues, in contrast, perhaps because they feel that they have a better command of the fundamental elements of statistics, do not attach the correct value to statistics, to the true significance of studying statistics, and as a direct consequence attribute little educational value to the discipline. In addition, according to the primary school teachers, in order to enhance the educational value of the discipline examined, the most important strategy is to concentrate on specific teacher training, while for secondary school teachers more importance should be given to the use of really effective teaching methods. All the teachers agreed that the lack of suitable textbooks does not help them in their task.

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