

Teaching Statistics at School: a Significant Experience in Italian Elementary Classes

L'insegnamento della statistica nella scuola: resoconto di una esperienza significativa nella scuola elementare

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Riassunto: Obiettivo della nostra ricerca era di introdurre lo studio della statistica nella scuola elementare attraverso un approccio inusuale in Italia: il Data Oriented Approach e tramite la strategia didattica per mappe concettuali. La ricerca è stata svolta nell'anno scolastico 1999-2000 nelle province di Treviso, Perugia, Palermo, Pordenone e Oristano, coinvolgendo 145 insegnanti e 2129 alunni (6-10 anni). Tutti gli insegnanti coinvolti hanno seguito, preliminarmente, un corso di preparazione su concetti di base della statistica e sulla pedagogia per concetti. La sperimentazione, basata sulle mappe concettuali, ha dato esiti molto positivi per quanto riguarda l'acquisizione di concetti statistici e semplici tecniche di raccolta ed analisi dati.

Keywords: Teaching Statistics, Elementary School, Concept Map.

1. Introduction

There is now a general agreement in the international scientific community on the idea that the teaching of statistics should be given a broad scope because of the relevance that the activities of collecting, representing and processing data have taken over in contemporary society and in consideration of the growing use of statistical methods in making predictions. The idea that the teaching of statistics should emphasise the understanding of statistical concepts and methods and also encourage the students to acquire awareness of how important it is to be able to assess the mass of statistical information they come across every day has a similar consensus. In our country the teaching of statistics, besides being marginal and incorporated in the mathematical curriculum, is very often dealt in an abstract and formal way. There is very limited emphasis on the meaning of concepts and even less on the interpretation of the results. Students need to see mathematics and statistics in a correct perspective and to distinguish the different features of their logic. In particular, it is fundamental to enable learners to appreciate the role of statistical reasoning, which allows them to read and interpret real phenomena with no pretension of giving "exact answers", nevertheless

helping them to develop a more objective view of reality. For these reasons, a research was organised by CIRDIS¹ and the Statistics Departments of the Universities of Padova, Palermo and Perugia, supported from the Italian Ministry of University and Scientific Research.

2. The experimentation at school

One of the aims of primary school is to provide pupils with skills for describing and interpreting the world around them. Such descriptions often require the use of numbers, graphs and diagrams. Teachers carry out researches in many subjects handling data, representing them in tables and graphs, interpreting them and obtaining information from them. To grasp these skills it is necessary to teach Statistics in the elementary school. The ministry of education provided the Italian primary school syllabus for basic statistical concepts in the 1985. Those contents are introduced in two ways: 1) Statistics as *a method* (as a part of mathematics); 2) Statistics as *a tool* (related to mathematics, science and geography). The new Italian school reform ("riforma Moratti", 2004) that is going to become effective, gives importance to Statistics (called "*Data and Previsions*"). For these reasons, a study was carried out on the teaching of statistics in primary schools (Rigatti Luchini et al., 2000). Its purpose was to evaluate the efficiency of a teaching approach based on concept maps and nets rather than a classic one in which notions remain isolated and separated. This approach consists in concept maps, nets and semistructured interviews used both as guidelines of the class activities or as method of assessing students. Concept maps include the concepts (referred to as nodes and often represented visually by ovals or rectangles) and the connections (referred to as links and often represented with segments or arrows) that relate them (Gal and Garfield, 1997). The semi-structured Interview or Clinical Conversation is a class-interview with stimulating and specifying questions, aiming to explore the students' spontaneous knowledge with regard to concepts that the teacher wants to introduce in the class.

In primary schools it is much more important to check the process of concept acquisition than that concerning technical abilities. Previous studies had already shown that teachers and pupils learn basic statistical notions without knowing they are dealing with statistics at all: they gather data, try to reproduce it in a chart, they calculate the average, and so on, but are unable to analyze and evaluate it (Perelli D'Argenzio et al., 1998). That is why this teaching has to be given in a clear subject frame and in a clear didactic frame. Every teacher has to be conscious of the basic concepts and contents of Statistics he/she is teaching otherwise the teaching of statistics may become formal and without any effect in the real life of pupils. We choose the Data Oriented Approach (that consists in working with real data) on the hypothesis that working with real data reflecting a phenomenon of daily life favours structured learning. We attempted this during the school year 1999-2000 in five cities from North to South Italy². The experimentation involved 145 teachers and 2129 pupils.

¹ CIRDIS is an Inter-University Centre of Research for the Teaching of Statistical Disciplines that includes the Universities of Rome, Padua, Perugia and Palermo.

² Treviso, Pordenone, Perugia, Palermo and Oristano.

Teachers had an in-service training for 32 hours, the contents of which are as follows: 1) basic statistical concepts, gathering and elaboration of data, stem and leaf diagrams, table and graph representation, the meaning of variability and related elementary notions; 2) basic notions on how to evaluate data critically, how to analyze it to obtain correct information, how to perceive and describe the validity and meaning of data and means; 3) elements of educational psychology for the teaching of statistics in primary school; 4) Concept map models; class semi-structured interviews, conceptual maps and nets. This in-service training was absolutely necessary because no teacher had statistics in his personal training before. Then teachers had teaching units to be used in classes. Units were organized into 3 levels: ages 6-7, 8-9 and 10. Every unit contained on the left side proposals for the pupils' activity, on the right sides hints for the teachers, possible teaching problems which might arise at this point and possible variations of tasks. Teachers focused on learning processes rather than the product of learning or required skill standards. Then they analyzed the pupils' ideas and conclusions through written exercises, class discussion and semi-structured interviews. Teachers started from a *psychologically structured concept map*. The map avoids *samples* deliberately, because the purpose of the study is the *population*. For the class activity, teachers used different maps containing children's everyday terms and experiences that could be related to basic statistical notions: giving preferences; carrying out a study, a report or a survey. Pupils had two class interviews on the meaning of words which appeared in the map of their class: one at the beginning of statistical work and one at the end. This enabled teachers to compare the ideas pupils had before statistical activity and after class work. We focused our attention in the primary school on the problem of representation, which involves four main phases: 1) the manipulation of raw data drawn from pupils; 2) the collection in a disorderly way; 3) the representation in an arbitrary way; 4) the drawing of pictograms after a class discussion. It is then that pupils manage to draw block graphs without using numbers and proportionality. Teachers found that class interviews were an excellent tool in highlighting the individual's and the group's knowledge both at the beginning and at the end of the teaching experience. The interview at the beginning of the teaching unit shows how pupils refer to their personal experience at and outside school and how further class discussion changes and completes their ideas leading to a specific knowledge which is supplemented by their real life and experience, but cannot be considered a proper knowledge yet.

3. Conclusions

All children undergo positive changes after the teaching activity. Children are now able not only to collect data and to manipulate them, but they have also *the critical capacities to inspect them*. Although in a childlike way, the fundamentals of statistics have been understood. In every class teachers interviewed pupils on the terms inquiry and survey, at first at the beginning of the statistics class activity and afterwards at the end.

For example, in a class pupils said in the first interview that the meaning of these terms was: *-looking for evidence in case of theft, murder, or similar; - a kind of research you carry out among people and you try to find out information; -looking for information to know something well; -finding information in what people say; -in my opinion inquiry means revealing mysteries like policemen; -survey means to ask something*. These

answers reveal that terms and experience are connected; there is no pre-knowledge related to the use of statistical terms; the term statistics never appears; information is rather confused; only one child associated the term inquiry with research, but this did not happen with the other children.

In the final interview on the same terms/concepts, inquiry and survey are considered as synonyms whose meaning is thorough research: *-you need to fill in a questionnaire, ask for information; -for example the population census that will be taken next year is an inquiry because we want to know how many we are, what we do; -a survey could be a statistical survey, for example we drew stem and leaf diagrams to get information; -you consider the pupils in this classroom and ask how many people there are in each family; -survey means investigate and gather data.* These remarks highlight appropriate use of terms; appearance of the term statistics; connection between terms and concepts.

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