The implicative analysis on a performance test

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1. Aims and Methodology

The implicative analysis which is an important instrument in didactic research (Spagnolo 1998), is used here with a group of middle secondary school pupils in order to find out if there are basic concepts of statistics that imply the comprehension of other, more complex or more articulated ones. The implicative analysis has been realised through the creation of implicative or tree graphics that both single out logical paths and implications about the contents of a progress test and offer the possibility to check and choose the level of acceptability of the implications found. (Gras, 1996 e 1997).

The performance test was given to 1,545 pupils of the middle secondary school during the 2001 year, in four Italian cities that took part in the project concerning the experimentation of new didactic strategies for statistic learning. (Milito *et al.*, 2002). It was made up of 37 sub-items concerning the statistical contents used during the test in classroom: the concepts of population, units and characters, characters classification criteria, information gathering criteria and their graphic representation, as well as the most elementary forms of elaboration of distributions (relative and per-cent frequencies, average values and variation ranges). According to the implicative analysis, a value equivalent to 1 was assigned to every item if the answer is correct and 0 if the answer is wrong or missing. The students were divided into two groups, according to two didactic conditions: DOA (*Data Oriented Approach*) and the DOA and CL (C*ooperative Learning Method*).

2. Results

The implicative analysis, carried out with CHIC software, concerns the whole group of 1,545 students in the four cities involved in this experimentation with the two didactic conditions (DOA 770 and DOA with CL 775). The implicative analysis was carried on data relative to the school in Rome. (Ottaviani, 2001) but a further elaboration distributed in the other cities is still in being conducted.

The analysis results have showed , with a p-value equivalent to 0.01, that questions relative to the calculation and the percentage meaning are not linked to other statistical concepts present in the test; the ability to write three numbers so that the mean and the median have the same fixed value (the opposite of finding the solution) implies the ability to calculate the following mean values: mode, the median and the mean and the ability to read graphics; the ability to read graphics implies, from a conceptual point of view, the ability to organise not aggregated data inside a simple table and to read the most evident data; the concept of variability doesn't seem related to that of the average value, but only slightly to the construction of a simple distribution; a student who is able to build an histogram on data already presented in a table also knows the concept of the mean as well, finally, even if indirectly, a student who is able to answer questions related to the meaning of the mean knows the characters classification criteria and the table reading criteria.

Regarding occurrence, we notice that only a few people were able to write down three numbers so that mean and median can give the same result (about 20% in the group observed), while the meaning of the mean was understood by more than 60% of the students who took the test.

Reducing the analysis to two groups of students, according to the didactic condition DOA and DOA with CL, we can notice some differences, above all in the first group. From the results related to the 770 students who studied statistic with the DOA approach, in general, we notice the

following implications: a student who knows the concept of the mean, also understands its increasing or decreasing dynamics in different situations; a student who is able to organise not aggregated data in table form, can also read the quantitative information present in a simple graphic; the correct calculation of the variation coefficient depends only on the calculation of the mean.

Unlike the previously showed results, the mean meaning was understood by more than 70% of the students that took the test, while we confirm the low percentage of those who were able to write three numbers so that the mean and the median gave the same result. The concept of percentage remains independent from other statistical concepts.

For the 775 students who studied statistics with CL method, the implicative analysis was given more complex links, compared to the general situation and that of DOA group. In particular it seems clear that answering questions correctly about graphic reading implies answering questions about table reading; a student who is able to read quantitative information in a double table is also able to calculate average values of the mean and median as well.

From the implicative analysis results, one notices that percentage calculation is a simple concept compared to others as it may have already been acquired by students in maths lessons (every student correctly answered the corresponding question), while it becomes a new and more complex notion if one has to calculate in a double distribution. Indeed, only 10% answered this question correctly. Analysing the differentiated data for each didactic condition, there do not seem to be any important differences. The logical implications remain rather unchanged, while, on the contrary, the occurrence changes, that is questions that seem easier than they are thanks to one type of methodology and are slightly more complex with another. The CL method seems to be more effective in learning the exact way to build and read a simple table and for the relative notions of classification characters criteria. The DOA, on the contrary, is slightly better than the first method as concerns the percentage and average value calculation, in particular that of the arithmetical mean. The present analysis contains some initial reflections about the differences between the didactic methodologies adopted. We intend to continue the analysis with more homogeneous groups of students (using the different cities as varying element of classification) both in order to single out more evident links, and to try to better understand some unexpected results.

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RÉSUMÉ

L'étude suivante à comme objectif de rechercher quels sont les concepts de base qui demandent la compréhension de d'autres concepts plus complexes pour un groupe d'élèves de l'école intermédiaire de premier cycle. Les données sont tirées des résultats d'un test administré à la fin d'une expérimentation d'enseignement de la statistique qui mettait en place les approches didactiques: DOA et DOA et CL. Les résultats de l'analyse ont montré que la methode CL se révèle plus efficace pour l'apprentissage du moyen exact pour construire et lire les tableaux simples et pour les notions relatives aux critères de classification des caractères alors que l'approche DOA se révèle légèrement plus efficace pour l'apprentissage du calcul des pourcentages et des mesures de tendance centrales.